POWER

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PHILIP W. SWAIN, *Editor*

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FACTS, ideas and—above all—leadership are required of every technical journal that would serve its field. American industry dares not be satisfied with less. POWER has always recognized this responsibility, and today, as always, it is dedicated to the practical service of those who design, build and operate power plants of every sort.

As partners in this service, the publishers likewise have their peculiar responsibility: to select as Editor a man whose judgment, experience and all-around capacity fit him to lead in such an enterprise.

Because he has these qualities, it gives me great satisfaction to announce the appointment of Philip W. Swain as Editor of POWER. In taking this action, as America's oldest power-plant publication completes a half-century of life, the Executive Committee of the McGraw-Hill Publishing Company has considered, above all, the desires of the readers of POWER and the practical requirements of the industries it serves.

Throughout his twelve years of service with POWER, and particularly as Managing Editor in complete charge for the past year, Mr. Swain has demonstrated ability and leadership of a high order. He has proved himself, beyond question, to be worthy of the full editorial responsibility.

I have known POWER intimately for fifty years. Fred Low, Editor for forty-two years and Editor Emeritus since 1929, has been my close friend since that day in 1888 when he began his years of inspired leadership. I see today the results of that leadership permanently woven into the fabric of POWER.

In his years with POWER Mr. Swain has had the rare good fortune to serve for nearly a decade under Fred Low, drawing from him, as he still draws, inspiration and an understanding of the minds and hearts of men. He holds firmly to the POWER tradition of practical service, adding to it his own initiative, versatility and broad knowledge of the field.

He has also preserved another Low tradition, that of keeping constantly in touch with his readers. He has distinguished himself in every kind of editorial job, at home and in the field, and has been active in the committee work of several engineering societies. Even more important than this, I think, is the fact, that Mr. Swain has revealed himself as an engineer who possesses a creative imagination and who always applies that faculty to the job in hand.

His solid engineering training was founded at the very start on intensely practical work in shop and factory. In his early days, Mr. Swain had extended experience as a machinist and steam fitter. He has had charge of power-piping installations as job superintendent and field supervisor. He has conducted many power-plant tests and special research projects and has shown real ability as an engineer salesman. For two years, with ten months in France, he served as an officer of field artillery. Behind most of this practical experience, and supplementing it, are ten years of university work as student of the liberal arts, sciences and engineering and as a teacher of power engineering.

With this broad background, Mr. Swain has mastered the difficult job of getting out a modern technical magazine. Under his leadership, and with the teamwork characteristic of its editorial staff, POWER will maintain its best traditions, but will move forward with new times to meet the new problems of power engineers.

I extend to Philip Swain and his editorial associates on POWER the best wishes of the entire McGraw-Hill organization.

James H. McGraw

PHILIP W. SWAIN

POWER IN 1933

By R. B. PURDY
Associate Editor

Economic conditions have made power-plant designers "dollar-conscious"—Two new central stations in 1933

● HAND-IN-HAND with the sharp upturn in business and in public confidence, energy output from central stations began to rise so rapidly last March that in three months kilowatt-hours generated per week increased 18 per cent. Since then, the demand for electrical energy has held nearly constant at about 1,620 million kw.-hr. per week, well above that for 1932 and only slightly below 1931. In spite of this increase, there is little evidence on the part of utility operators of any intention to increase present generating capacity. This, no doubt, is because most utility systems had installed ample capacity before the start of the decline in power demand in 1930.

There may be in this situation an element of danger for the utilities, since connected domestic loads have grown steadily in the meantime. Should decided business improvement occur shortly, many utilities will find themselves unable to carry new peaks. A scramble for new equipment will result, and plants will be rushed to completion with inadequate attention to the details that make for both dollar and thermal economy. The wise utility will spend money today in new plant studies or even in actual plant additions, to be prepared for the future.

One thing present economic conditions have done for the engineer charged with plant designs—they have made him "dollar minded." Indications are that plants of the future will be designed for "dollar economy" rather than for the ultimate in thermal efficiency. Likewise, less money will be spent for fancy architecture, luxurious space around equipment and other unnecessary and costly frills.

Plants designed for 1,200-lb. pressure have proved as reliable as 450-lb. installations. The Edison Electric Institute report shows an outage factor of 4.26 per cent for high-pressure turbines, substantially the average outage factor reported for low-pressure turbines. High-pressure installations have also been found flexible in operation. Reports from Station A of Pacific Gas & Electric Co., for example, indicate that a 61,000-kw. unit can pick up a 51,000 kw. load in 36 sec.

In spite of the proved performance of the 1,200-lb. plant, no installations in this pressure range were made during the year. Instead, 600-lb., 825 deg. has been favored, as illustrated by the new Buzzard Point plant and by the plant additions at Burlington, N. J., Connors Creek, Detroit and Honolulu. By dropping the pressure to 600-lb. and increasing the temperature, reheaters are eliminated. The increased simplicity thus obtained and the satisfactory experience with 825-deg. steam are underlying reasons for the trend.

Experience at Detroit shows that plants for 1,000 deg. can be built to operate satisfactorily. Nevertheless, it appears that at present 900 to 950 deg. will be more economical, as it permits use of cheaper materials. These temperatures permit pressures of 800 to 900-lb. without reheat. Plants designed for these steam conditions can be looked for in the future.

Only two central stations have been built and placed in operation during the year—one the 35,000-kw. Buzzard Point plant of Potomac Electric Power Co. and the other the 26,000-kw. mercury-vapor installation of the General Electric Co. at Schenectady, which is to be operated by New York Power & Light Co. It would be dangerous to predict trends in utility power-plant design from these two stations, particularly since they represent advanced power engineering in quite opposite directions. Buzzard Point represents the more conventional plant, reflecting an existing trend to the "unit design" of one boiler for each turbine.

Features of the plant are the single-pass boilers and the elaborate provision for collecting fly ash from the flue gas. The very high-head boiler is provided with an economizer placed inside the boiler setting and feeding the boiler drum through tubes instead of the usual pipe. Special provisions have been made in the turbine room to avoid the hazard of oil fires. Even greater attention was centered on this danger by the disastrous oil fire involving the new 18,000-kw. turbine at Burlington. This turbine was completely rebuilt and recently placed back in service. From this and similar accidents has resulted an insistent demand for a non-inflammable liquid satisfactory for turbine lubrication and governing. One such fluid is now being used in the governing mechanisms of three turbines and as a lubricant in one small 5,000-kw. unit.

The 20,000-kw. mercury turbine and the 6,000-kw. steam unit at Schenectady have both been put in operation. The plant is outstanding not only because it is the first to be designed from the start as a mercury plant, but also because it is the first "outdoor" plant.

There exists considerable divergence of opinion regarding the economy of "outdoor" power-plant construction. Many engineers feel that the cost of pro-

tecting out-of-door equipment and increased operating difficulties offset the somewhat doubtful saving in building cost. At Schenectady, the turbines, mercury-steam boilers and evaporators are not housed, whereas most of the other equipment is, though not in the conventional manner.

The mercury "top" at the Kearny plant was also placed in operation and has carried full rated load of 20,000-kw. on the mercury turbine. As at South Meadow, the Kearny mercury turbine and mercury condensers are placed above the boilers, which are fed by gravity. But at Schenectady, the conventional turbine room location has been adhered to and a mercury feed pump is employed. At both plants, the boilers have mercury and water furnace walls.

Except for the mercury cycle, little activity is discernible in binary cycles. Several other fluids, such as anhydrous aluminum bromide, zinc ammoniacates and Dowtherm, are being investigated for heat-transfer mediums.

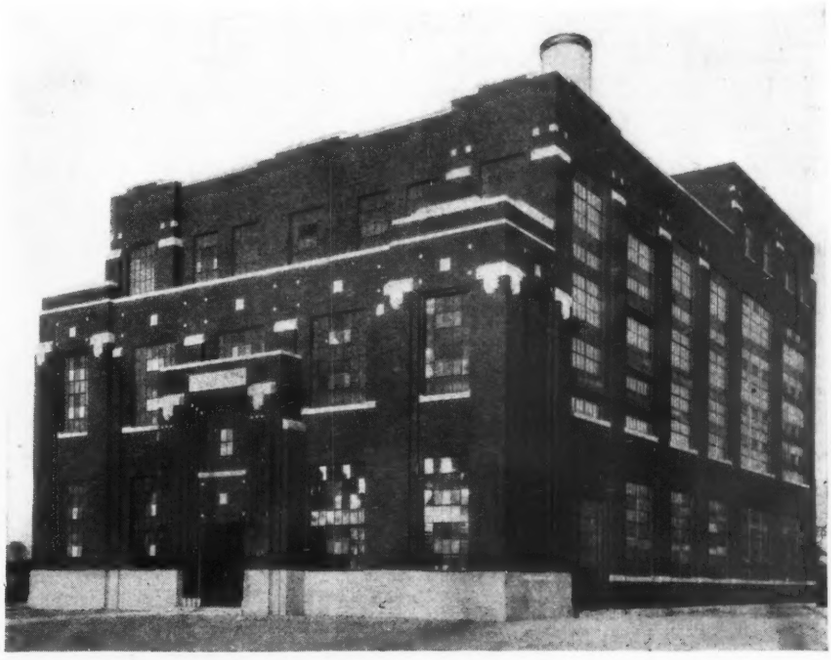
Significant, because of the work the Detroit Edison Co. has done with 1,000-deg. steam, is the modernization program in progress at that company's Connors Creek plant. Two of the old boilers are being replaced by two 24,920-sq.ft., six-drum units designed for 710-lb. per sq.in. pressure and 850 deg. F. Steam from these will be supplied to two 30,000-kw. condensing turbines which replace two 20,000-kw. units, parts of which are being used in the new high-pressure units. The two generators were previously driven by low-pressure turbines, which are also being removed. A third 50,000-kw. unit was placed in operation in Delray No. 3.

The new Port Washington station of Milwaukee Electric Railway & Light Co. has not as yet gone into operation. The initial installation is an 80,000-kw. tandem unit to operate at 1,390-lb. pressure and 840 deg. F. The 150,000-kw. turbine for State Line has been delivered, but has not been erected. Construction of the 125,000-kw. unit on order for the same station is still being held up. Construction of the 165,000-kw. Richmond unit of Philadelphia Electric Co. is progressing, and the unit is expected to go into operation early in 1935.

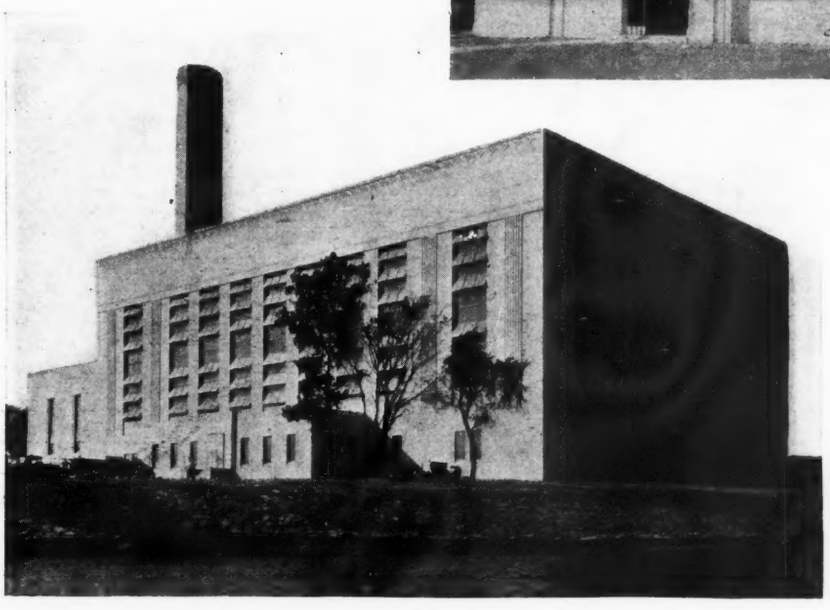
Municipal Plant Construction Increases

Activity in municipal power-plant construction has increased during the year, sixteen plants having installed new equipment, as shown in the tabulation. Whether this reflects a trend toward municipal plants, or an effort on the part of municipalities to help employment cannot be told. Eleven of the plants listed have added generating capacity.

Only two new municipal plants have been built and placed in operation during the year, one at Piqua, Ohio, and the other at Wyandotte, Mich. The plant at Piqua



Municipal plant at Piqua, Ohio, contains two 4,000-kw. turbines



Buzzard Point, the only new central station placed in operation in 1933

Steam Plants Placed in Operation

Company	Name of Plant and Location	Boilers: Number	Boilers: Max. Capacity, Lb. Per Hr. Ea.	Boilers: Pressure, Lb. Per Sq. In.	Steam Temp., Deg. F.	Economizers: Number	Economizers: Surface, Sq. Ft.	Air Preheater: Number	Air Preheater: Surface, Sq. Ft.	Firing Method	Forced Fans: Number	Forced Fans: Capacity, c. f. m.	Induced Fans: Number	Induced Fans: Capacity, c. f. m.
Central Station Plants														
Milwaukee Electric Railway & Light Co...	Port Washington.....	1	690,000	1,390	849	..	.....	2	60,500	Bin. P. C.	2	112,500	2	185,000
Chicago District Electric Gen. Corp.....	State Line.....	..	.....	1,200	825	..	.....	..	.....	.....	..	.....	..	.....
Potomac Electric Power Co.....	Buzzard Point.....	2	375,000	730	835	2	11,197	2	46,998	Unit P. C.	4	50,000	4	84,000
Detroit Edison Co.....	Connors Creek.....	2	435,000	710	850	2	8,640	4	14,450	U. Stoker	2	101,000	2	181,000
Hawaiian Electric Co.....	Honolulu.....	1	9,380*	650	825	..	.....	..	.....	.....	..	.....	..	.....
Detroit Edison Co.....	Delray No. 3.....	..	.....	400	700	..	.....	..	.....	.....	..	.....	..	.....
Philadelphia Electric Co.....	Richmond.....	2	3,800*	375	825	..	.....	..	.....	.....	..	.....	..	.....
Montana Dakota Power Co.....	Kincaid.....	2	36,000	300	525	..	.....	2	3,500	Chain Grate	2	22,000	2	36,000
Public Service Electric & Gas Co.....	Kearny.....	1	Mercury	125	958	..	.....	1	41,500	P. C. & Oil	1	120,000	1	204,000
General Electric Co.....	Schenectady.....	1	Mercury	125	958	..	.....	..	.....	P. C.	..	.....	..	.....
		1	300,000	400	760	..	.....	..	.....	.....	..	.....	..	.....
Municipal Plants														
Austin.....	Austin, Texas.....	2	120,000	475	725	..	.....	4	16,370	Oil & Gas	2	40,000	..	.....
Wyandotte.....	Wyandotte, Mich.....	2	45,000	450	700	..	.....	2	.....	U. Stoker	2	.....	2	.....
Taunton.....	Taunton, Mass.....	1	100,000	450	725	..	.....		Regen.	.....	..	.....	..	.....
Richmond.....	Richmond, Ind.....	2	96,000	450	750	..	.....	2	4,720	U. Stoker	2	33,000	2	41,500
Kansas.....	Kansas, Kan.....	1	180,000	450	750	1	2,035	1	19,500	P. C.	1	194,000	1	250,000
Colorado Springs.....	Colorado Springs, Colo.	1	65,000	425	750	..	.....	1	11,450	Gas	1	26,400	1	49,700
Piqua.....	Piqua, Ohio.....	2	60,000	400	700	..	.....	2	1,625	Chain Grate	2	16,000	2	47,500
Shelby.....	Shelby, Ohio.....	2	45,000	250	650	..	.....	..	.....	U. Stoker	..	.....	..	.....
Gainesville.....	Gainesville, Fla.....	1	7,680*	250	500	..	.....	..	.....	.....	..	.....	..	.....
Holyoke.....	Holyoke, Mass.....	..	.....	210	540	..	.....	..	.....	.....	..	.....	..	.....
Dover.....	Dover, Del.....	1	30,000	200	510	..	.....	..	.....	.....	..	.....	..	.....
Peru.....	Peru, Ind.....	..	.....	...	...	..	.....	..	.....	.....	..	.....	..	.....
Blue Earth.....	Blue Earth, Minn.....	..	.....	...	...	..	.....	..	.....	.....	..	.....	..	.....
Carlyle.....	Carlyle, Ill.....	..	.....	...	...	..	.....	..	.....	.....	..	.....	..	.....
Alexandria.....	Alexandria, Minn.....	..	.....	...	...	..	.....	..	.....	.....	..	.....	..	.....
Springwells Pumping Station.....	Detroit, Mich.....	2	70,000	375	710	2	2,430	2	9,980	U. Stoker	2	45,000	2	75,000
Industrial Plants														
Goodyear Tire & Rubber Co.....	Akron, Ohio.....	1	300,000	800	740	..	.....	1	.....	P. C.	..	.....	..	.....
Westinghouse Elec. & Mfg. Co.....	Mansfield, Ohio.....	1	35,000	500	625	..	.....	..	.....	U. Stoker	1	16,000	..	.....
Champlain Wood Products Co.....	Plattsburg, N. Y.....	3	30,000	500	...	..	.....	..	.....	P. C.	..	.....	..	.....
Bogalusa Paper Co.....	Bogalusa, La.....	1	10,217*	450	710	..	.....	1	17,700	Oil & Gas	1	50,000	1	78,000
Forstmann Woolen Co.....	Garfield, N. J.....	2	80,000	450	610	..	.....	2	6,500	P. C.	2	28,500	2	55,000
Wilson & Co., Inc.....	Chicago, Ill.....	3	130,000	420	550	3	4,830	3	13,786	P. C.	3	3,250[1]	3	3,500[1]
Rhinelander Paper Co.....	Rhinelander, Wis.....	1	8,340*	415	550	1	6,600	..	.....	U. Stoker	1	42,000	1	62,000
Crocker Burbank Co.....	Fitchburg, Mass.....	2	5,030*	405	...	2	2,500	..	.....	P. C.	..	.....	..	.....
Westinghouse Elec. & Mfg. Co.....	Trafford, Pa.....	..	.....	400	750	..	.....	..	.....	.....	..	.....	..	.....
American Enka Corp.....	Enka, N. C.....	1	75,000	400	700	..	.....	1	7,700	P. C.	1	104,000	1	132,000
The Logan-Long Co.....	Franklin, Ohio.....	1	40,000	300	570	..	.....	..	.....	U. Stoker	1	18,000	..	.....
Beloit Iron Works.....	Beloit, Wisc.....	2	30,000	275	500	..	.....	..	.....	Chain Grate	..	.....	..	.....
Marshall Field Estate.....	Field Bldg., Chicago...	4	25,000	260	Sat.	..	.....	..	.....	Chain Grate	..	.....	..	.....
Associated Oil Co.....	Avon, Calif.....	2	88,000	250	506	..	.....	..	.....	Gas	..	.....	..	.....
Kalamazoo Vegetable Parchment Co.....	Kalamazoo, Mich.....	1	150,000	250	650	..	.....	1	16,650	Unit P. C.	1	51,000	1	80,000
Jewell Ridge Coal Corp.....	Richlands, Va.....	2	3,030*	250	550	..	.....	..	.....	U. Stoker	1	.....	2	.....
International Business Machines Corp.....	Endicott, N. Y.....	1	83,000	250	556	..	.....	..	.....	Stoker	1	30,000	1	65,000
Shelby Cotton Mills.....	Shelby, N. C.....	2	36,000	250	505	..	.....	..	.....	Stoker	1	.....	..	.....
Forstmann Woolen Co.....	Passaic, N. J.....	3	60,000	250	506	..	.....	3	5,660	Unit. P. C.	3	20,000	3	36,200
Diamond Match Co.....	Barberton, Ohio.....	2	30,000	225	Sat.	..	.....	..	.....	P. C.	..	.....	..	.....
Freeport Sulphur Co.....	Grande Ecaille, La.....	6	52,000	225	397	..	.....	..	.....	Oil	..	.....	3	147,000
American Chicle Co.....	Long Island City, N.Y.	..	.....	185	Sat.	..	.....	..	.....	.....	..	.....	..	.....
Brown & Williamson Tobacco Corp.....	Louisville, Ky.....	1	4,840*	170	Sat.	..	.....	..	.....	U. Stoker	..	.....	..	.....
Great Western Sugar Co.....	Billings, Mont.....	1	9,834*	160	370	..	.....	..	.....	Chain Grate	..	.....	..	.....
Pacific Coast Torpedo Station.....	Keyport, Mass.....	2	15,000	150	366	..				Oil	..	.....	..	.....
Puget Sound Navy Yard.....	Bremerton, Wash.....	..	.....	...	...	..	.....	..	.....	.....	..	.....	..	.....
Fairmont Creamery Co.....	Columbus, Ohio.....	2	31,250	150	379	..	.....	..	.....	U. Stoker	1	.....	..	.....
Ambassador Hotel.....	Los Angeles, Calif.....	1	1,200	150	360	..	.....	..	.....	.....	..	.....	..	.....
R. H. Macy & Co.....	New York, N. Y.....	..	.....	140	Sat.	..	.....	..	.....	.....	..	.....	..	.....
C. G. Conn Ltd.....	Elkhart, Ind.....	1	2,534	125	Sat.	..	.....	..	.....	U. Stoker	1	8,750	..	.....
Container Corp. of America.....	Cincinnati, Ohio.....	1	84,000	175	477	..	.....	..	.....	U. Stoker	..	.....	1	.....
Institutional Plants														
Purdue University.....	LaFayette, Ind.....	3	44,740	210	494	..	.....	..	.....	U. Stoker	3	64,000	..	.....
Springfield City Hospital.....	Springfield, Ohio.....	3	2,510*	180	Sat.	..	.....	..	.....	U. Stoker	..	.....	..	.....
New York City Harlem Hospital.....	New York, N. Y.....	4	3,400*	175	Sat.	..	.....	..	.....	Oil	..	.....	..	.....
Queens County Hospital.....	New York, N. Y.....	4	32,000	175	Sat.	..	.....	..	.....	Oil	..	.....	..	.....
U. S. Soldiers Home.....	Washington, D. C.....	4	18,000	160	495	..	.....	..	.....	Oil	..	.....	..	.....
California State Prison.....	San Quentin, Calif.....	1	2,700*	125	350	..	.....	..	.....	Oil	..	.....	..	.....
Tuskegee Institute.....	Tuskegee, Ala.....	2	2,475*	160	370	..	.....	..	.....	U. Stoker	..	.....	..	.....
Eastern State Hospital.....	Williamsburg, Va.....	2	2,550*	125	Sat.	..	.....	..	.....	U. Stoker	1	.....	..	.....
St. Mary's Memorial Hospital.....	Montreal, Can.....	2	12,500	100	Sat.	..	.....	..	.....	Oil	2	.....	1	20,000
U. S. National Training School for Boys...	Washington, D. C.....	1	9,000	100	337	..	.....	..	.....	Hand Fired	..	.....	..	.....

* Sq. Ft. Heating Surface. [1]Lb. per Hr.

or Under Construction During 1933

Feed Pumps		Main Generating Units				Condensers		Circulating Pumps		Air Removal	Remarks
Number	Capacity, g. p. m.	Number	Type	Capacity, Kw.	Bleed Points	Surface, Sq. Ft.	Type	Number	Capacity, g. p. m.		
..	.....	1	Tandem Comp.	80,000	5	52,500	1-Pass	2	55,000	Twin 3 Stg. Jets	Under Construction. New Plant.
..	.....	1	Tandem Comp.	150,000	..	.....	.....	..	.....	.....	Under Construction.
		1	Tandem Comp.	125,000							
3	800	1	Turbine Cond.	35,000	3	30,000	1-Pass	2	25,000	Steam Jets	Cottrell Precipitator. In Operation New Plant.
4	650	2	Turbine Cond.	30,000	4	27,000	2-Pass.	1	36,000	Reciprocating	Modernization Project. Under Construction
..	.....	1	Turbine 3600 R.P.M.	10,000	..	.....	.....	..	.....	.....	In Operation. "Top" on Existing Plant.
..	.....	1	Turbine	50,000	4	50,350	1-Pass.	2	60,000	Reciprocating	Plant Addition in Operation.
..	.....	1	Tandem Turbine	165,000	3	.....	.....	..	.....	.....	Under Construction Plant Addition.
2	110	1	Turbine	2,000	..	3,060	2-Pass.	1	4,150	Steam Jet	Plant Addition in Operation.
..	.....	1	Mercury Turbine	20,000	0	.....	.....	..	.....	Steam Jet	In Operation.
..	.....	1	Mercury Turbine	20,000	..	.....	.....	..	.....	.....	In Operation.
..	.....	1	Turbine	6,000	..	.....	.....	..	.....	.....	.....
3	350	1	Turbine	7,500	3	10,000	2-Pass.	1	13,200	Two Stg. Steam Jet	In Operation.
2	.....	1	Turbine	3,000	1	3,000	2-Pass.	1	3,800	Steam Jet	In Operation, New Plant.
..	.....	1	Turbine	7,500	..	8,500	.....	..	.....	.....	Plant Addition in Operation.
3	600	1	Turbine 3600 R.P.M.	15,000	3	15,180	2-Pass.	..	.....	Steam Jet	In Operation.
2	800	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	150	1	Turbine	5,000	2	6,028	2-Pass.	1	7,500	Steam Jet	In Operation.
2	125	2	Turbine	4,000	4	6,000	2-Pass.	2	6,500	Steam Jet	New Plant in Operation.
2	225	..	.....	.....	..	.....	.....	..	.....	.....	1,500 Kw. Turbine Planned for 1934.
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Replaces 2 H.R.T. Boilers.
..	.....	1	Turbine	5,000	..	.....	.....	..	.....	.....	Addition Under Construction.
2	250	1	Turbine	1,250	..	1,600	2-Pass.	1	1,950	Centrifugal	In Operation.
..	.....	1	Turbine	5,000	..	9,500	2-Pass.	..	.....	.....	Addition in Operation.
..	.....	..	.....	500	..	.....	.....	..	.....	.....	Under Construction.
..	.....	..	.....	500	..	.....	.....	..	.....	.....	Under Construction.
..	.....	..	.....	1,500	..	.....	.....	..	.....	.....	Under Construction.
3	300	2	Turbines	5,000	..	.....	2-Pass.	4	4,025	Steam Jet	4-500 Kw. Aux. Turbines Under Construction.
..	.....	1	Turbine, Back Press.	8,000	1	.....	.....	..	.....	.....	Under Construction.
2	100	..	.....	.....	..	.....	.....	..	.....	.....	In Operation.
..	.....	1	Turbine	2,500	..	.....	.....	..	.....	.....	Under Construction.
2	600	1	Turbine, Back Press.	7,500	1	.....	.....	..	.....	.....	In Operation.
1	300			2,500							
2	200	3	Turbine	2,000	1	.....	2-Pass.	..	.....	.....	In Operation—New Plant.
				300							
				1,500							
4	310	3	Turbine	2,000	1	.....	.....	..	.....	.....	Under Construction.
				2,500							
..	.....	1	Turbine	5,000	..	.....	.....	..	.....	.....	.....
..	.....	1	Turbine	1,500	..	.....	.....	..	.....	.....	In Operation.
				3,000							
..	.....	3	Turbine	500	1	.....	2-Pass.	..	.....	.....	Addition Under Construction.
				500							
2	150	..	.....	.....	..	.....	.....	..	.....	.....	Operation at 250 lb. Press. Replaced Old Boiler
2	.....	2	Turbine	695	1	600	.....	1	800	.....	.....
3	75	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	165	..	.....	.....	..	.....	.....	..	.....	.....	In Operation.
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Under Construction.
2	8x5x12	2	Turbine	1,000	1	1,150	2-Pass.	2	1,200	Steam Jet	In Operation.
..	.....	1	Engine	500	..	.....	.....	..	.....	.....	In Operation.
2	75	1	Turbine	1,200	1	1,400	2-Pass.	1	1,920	Steam Jet	In Operation.
				1,250	2	800					
..	.....	3	Turbine	750	1	338	2-Pass.	2	1,250	Steam Jet	In Operation.
				300							
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Replaces Old Boiler.
4	640	3	Turbine	750	..	.....	.....	..	.....	.....	.....
				500							
..	.....	3	Turbine	380	..	.....	.....	..	.....	.....	In Operation.
				140							
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	1	Turbine	1,500	..	.....	.....	..	.....	.....	Addition in Operation.
..	.....	1	Turbine	500	1	1,000	2-Pass.	1	50	Steam Jet	In Operation.
..	.....	1	Turbine	3,000	1	4,500	2-Pass.	1	150	Steam Jet	In Operation.
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	1	Turbine, Mixed Press.	1,000	..	3,500	2-Pass.	1	2,700	Steam Jet	In Operation.
2	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
1	400	1	Turbine, 3600 R.P.M.	2,500	1	2,530	2-Pass.	1	4,350	Steam Jet	In Operation.
2	10x6x10	2	Engine	300	..	.....	.....	..	.....	.....	.....
3	9x6x12	3	Engine	200	..	.....	.....	..	.....	.....	.....
				100							
3	.....	1	Engine	100	..	.....	.....	..	.....	.....	Completed.
		2		250							
..	.....	3	Turbine	1–500	..	.....	.....	..	.....	.....	.....
				2–300							
1	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	150	3	Engine	50–50–75	..	.....	.....	..	.....	.....	.....
2	40	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	53	..	.....	.....	..	.....	.....	..	.....	.....	.....

is designed to operate at 400-lb. pressure and 700 deg. F. It contains two 4,000-kw. condensing turbines with 4-stage extraction and two boilers of 60,000-lb.-per-hr. capacity, fired by chain grates. The plant has all the aspects of a modern utility power plant. The total cost of this plant, including the distribution system, was $88 per kw. of installed capacity.

The Wyandotte plant has an initial capacity of 3,000-kw. in one turbine, which is supplied with 450-lb., 700-deg. steam from two underfeed stoker-fired boilers of 45,000-lb.-per-hr. capacity.

Higher Pressures For Industrial Plants

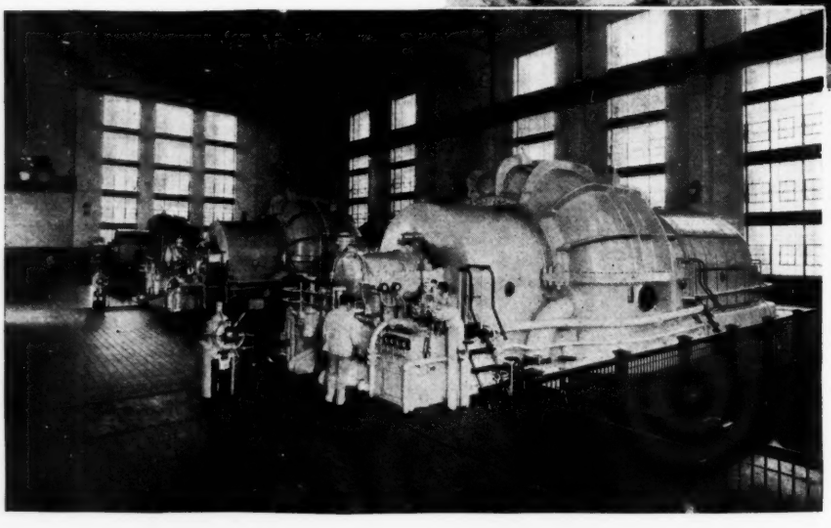
More effort is being made by industrial power plant designers to obtain a more nearly exact balance of steam and power requirements. This has resulted in the selection of 800-lb. pressure and 740-deg. as the steam conditions for the 8,000-kw. unit being installed by Goodyear Tire & Rubber Co., Akron, Ohio. Champlain Wood Products Co. has under construction a 2,500-kw. plant to operate at 500-lb. and Bogalusa Paper Co. has placed in operation a 7,500-kw. unit operating at 450-lb. pressure and 710 deg. F., indicating that industrials are by no means limited to 400-lb. steam pressures in their power plants.

An excellent example of industrial power plant engineering is to be found at the Forstmann Woolen Co.'s power plants at the Garfield and Passaic Mills. At the Passaic mills, the amount of process steam required was large in proportion to the power requirement, so 250-lb. pressure was found adequate. At Garfield, however, the reverse was true, and 450-lb. pressure was required to generate the power required from process steam. These plants, of 2,300 and 4,800-kw. capacity respectively, are excellent examples of industrial power plants. Both were placed in operation during the year.

A plant modernization which is yielding a daily saving of $650 was completed at Bogalusa Paper Co., Bogalusa, La., where a 10,000-sq.ft. gas-fired boiler was installed in place of three wood-burning boilers. The unit, designed for 450-lb. pressure, supplies steam to a new 7,500-kw. turbine exhausting at 25-lb. pressure and arranged for steam extraction at 160-lb.

It will be noticed from the plant construction table that few steam-engine installations have been made. This may be due to the decrease in the construction of institutional plants which have been the largest users of steam engines, as shown by past construction tabulations.

There are some indications of a trend toward combined steam and diesel plants. The advantage of such combination is that the highly efficient diesel engine may be used during periods of low process-steam requirements. Two examples of such installations placed in operation late in 1932 are to be found in the municipal plant of Marshall, Minn., and the power plant of Pau Corp. serving the Union Stockyards, Chicago. The 875-hp. diesel at Marshall is used for peak-load service and during the summer when there is no demand for heating steam. At the Union Stockyards, a 3,000-hp. diesel was installed to operate in conjunction with 14,700-kw. of steam capacity.



Both the steam and mercury units in the General Electric Co. plant have been placed in operation

A third 50,000-kw. turbine was placed in operation in Delray No. 3

SMOKE-PURE AIR

Large power plants get the blame; home-heating plants may cause all the trouble. Three central stations complete flue-dust eliminators; research provides a basis for further application

● INCREASING factory production brings increasing demands for power and steam, consequently increased smoke and air pollution. At the moment, smoke from factory chimneys is such a welcome harbinger of better times that there is little said against it. But smoke associations and committees are being reorganized and are again becoming active. There is also increasing realization that related combustion products that do not color the stack gas are often more serious than visible smoke, and that the great offenders are not central stations and large industrial plants, but the millions of home-heating plants, water craft, railroads, even automobiles. "We have yet to learn that pollution is still pollution, even when it comes in small packages."

Home-heating smoke is anywhere from one-tenth to five-sixths of total smoke emission, depending upon district and fuel. Of an annual smoke bill of $2,400,000,000, some $200,000,000 of it is in fuel wastage alone. Yet, attempting to make engineers of 120,000,000 Americans smacks of the impossible.

Large power plants necessarily bear the brunt of attacks on smoke emission. Some have gone to extraordinary ends to avoid any difficulty, classic examples being the 540-ft. stacks of the Leipzig-Norde station, which is in the center of a high-class residential section and burns very poor brown coal. This station also has electrostatic precipitators. In Paris, France, a recent law forbids emission of noxious gases from domestic and commercial establishments alike, and provides heavy fines for violations. Trains have been electrified, a new 500-apartment group uses electricity for heating and cooking (taking power at off-peak periods) and five super-power stations in the area have been equipped with gas purifiers. These latter remove 90-96 per cent of the grit and most of the sulphur with draft losses of but $\frac{1}{8}$ to $\frac{3}{8}$ in. of water.

Central stations are still most active in smoke abatement in this country. Hudson Ave. Station of Brooklyn Edison Co. has developed a new type cinder catcher (*Power*, page 598, November) which shows 80-84 per cent efficiency. Twelve catchers are in daily use on service boilers having total steaming capacity of 5,560,000 lb. per hr. These These units are low in cost, require small floor space, remove cinders efficiently, also some sulphur, and have given no operating troubles so far.

Buzzard Point has an extensive installation (*Power*, page 505, November), including special single-pass boilers without baffles. Cottrell electrostatic precipitators are installed three sections deep instead of the more common two, increasing fly-ash removal efficiency to 96 per cent or better. Automatic draw-off by vacuum air transport to cyclone separators permits ash to be handled dry until mixed with water as dumped into disposal trucks.

At Battersea, England's great new central station, a wet-washing system costing £246,000 was installed to remove 90-95 per cent of the sulphur dioxide from 1,500,000 cu.ft. of flue gas per min. This plant (*Power*, page 490, September) washes the gases (from coal with 1 per cent sulphur) with water in scrubbers containing iron oxide, with water in wood scrubbers, through sprays, an alkaline scrubber, and finally through a dry scrubber to remove entrained moisture.

The fly-ash problem is complicated by the fact that fly-ash recovery is expensive and saves no money, whereas smoke prevention increases boiler efficiency. As yet, no profitable outlet for fly-ash, beyond the possibility in making bricks, has been found.

Smoke abatement educational work has suffered seriously from depletion of municipal treasuries, necessitating curtailment or abandonment.

Industrial research has resulted in several commercial units, principally of the wet type. Mellon Institute has been taking a leading part in smoke abatement and air pollution investigations, publishing the results and also using them in a general educational campaign. Brooklyn Polytechnic Institute and Stevens Institute are studying the problem in the New York area, and several other schools are also working on research (*Power*, May, page 263). Both research and publication of results have been hampered by lack of funds.

Prof. H. F. Johnstone's researches at the University of Illinois have not yet produced a satisfactory solution to central station smoke-abatement problems, but they have determined underlying difficulties and power requirements for moving the tremendous volumes of gas to be treated. His present researches are with direct reaction methods. The U. S. Department of Public Health is continuing its survey in 14 major cities, which will provide comparable results.

Instruments and apparatus for smoke density determinations are increasing in number rapidly. Most of these are of the photo-electric type to fit breechings, although one or two are comparators. Part 20 of the A. S. M. E. Power Test Codes lists the various types of units and gives their relative efficiencies.

STEAM GENERATION

Changes in competitive positions of fuels and Appalachian Coals decision affect fuel purchases—New burners handle coal, oil and gas interchangeably or together—Definite trend toward all-welded boilers

● TWO ECONOMIC developments of the past year will affect fuel purchases of many steam-generating plants. The price of coal in most localities has been increased by acceptance of the N.R.A. Coal Code and the decision of the Supreme Court in the Appalachian Coal case. Oil conservation measures have likewise greatly increased fuel-oil prices. The pattern of relative values has completely changed. Therefore, the boiler-room engineer must re-survey his fuel purchases to continue generating the most steam for his fuel dollar. Oil and gas have been competing with coal for steam generation for a number of years, and this situation still continues.

Because of frequent changes in the competitive positions of solid, liquid and gaseous fuel, many installations have been made so that any of the three fuels can be used with minimum changes to firing equipment. To meet these conditions, manufacturers have brought out burners capable of burning either oil, gas or pulverized coal. Burner capacities have been increased—a single burner at West Virginia Pulp & Paper Co.'s plant burned sufficient coal to generate 135,000 lb. of steam an hour, representing a heat liberation of 205,000,000 B.t.u. per hr. This is said to establish a record. A multiple-fuel burner brought out during the year, shown in Fig. 1, is primarily for pulverized coal, but the change to oil or gas can be made quickly or a combination of these fuels may be burnt. Changes from coal to oil or gas have in most cases been accompanied by lowered steam temperatures due to decreased excess air. Excessive plugging of preheaters have been encountered in a number of plants using oil. Greater heat release per cubic foot of furnace volume is usually possible with oil or gas than with coal.

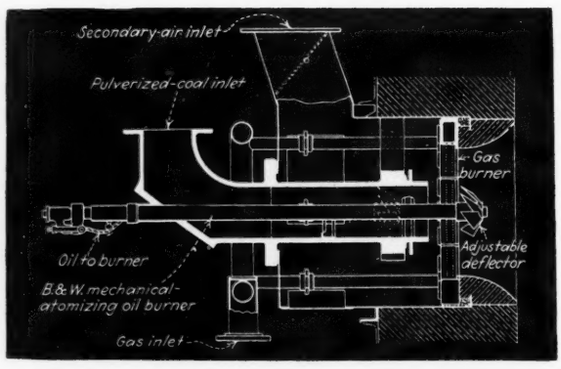
No new underfeed stokers of large capacity were made during the past year. Department of Commerce figures for ten months of 1933 show 355 stokers sold for use with water-tube boilers having a total surface of 1,302,980 sq.ft. During eleven months of last year, 80 pulverizers were sold for use with 648,209 sq.ft. of water-tube boiler surface. It thus appears that the stoker is still more popular than pulverized coal.

One of the 69-tuyere, 15-retort underfeed stokers at Hudson Ave. has been equipped with manually operated zoned air control of a type quite similar to that used at Beacon St. heating plant of Detroit Edison Co. The zoned air control has increased the capacity of this stoker, which had been somewhere between 350,000 and 400,000 lb. of steam per hr. Since installation of the control equipment, numerous high-output runs of 5- to 6-hr. duration have been made at about 530,000 lb. of steam per hr. This corresponds to a coal-burning rate of 85 lb. per sq.ft. of grate area per hr. A peak output of 640,000 lb. per hr. has been reached and sustained for a period of 1 hr. Maintenance on these stokers, based on burning 800,000 tons of coal during a 22-mo. period, has been about 6 cents a ton. This figure applies to maintenance of grates and ash pits, no maintenance having been required on gear boxes or hydraulic drive units.

Improvements in details are being made on underfeed stokers, but no major new development has occurred. Special materials for stokers for replacement have been used by a number of companies, but without marked economic advantage. A new control unit for hydraulic stokers automatically reverses the direction of the ram in case an obstruction is encountered, and can be at a distance from the stoker it controls. A number of small automatic stokers for 1,000- to 2,500-sq.ft. boilers have been developed.

Two outstanding traveling-grate stokers were placed in operation for burning anthracite at the St. Nicholas plant of Philadelphia & Reading Coal and Iron Co. The active length of each stoker is 23 ft. 7 in., it is 18 ft. wide having an effective grate area of 424.5 sq.ft. This is the largest stoker of this type burning anthracite.

Fig. 1—Burner for pulverized coal, oil or gas



The unit system of pulverized coal burning continues to be favored over the bin system. The Department of Commerce reports only four pulverizers sold for use with storage systems. The very few pulverizers for bin systems may be partially caused by the lack of utility plant construction, though in the only new utility plant of last year the unit system is used.

While no new principles of grinding have been established, detail improvements have been made on pulverizers to reduce power consumption and maintenance costs and to increase their availability for service. This permits the use of a relatively small number of large-capacity pulverizers with one boiler unit. In the latter part of 1932, the largest pulverizer so far built, having a capacity of 50 tons per hr., was placed in operation in the Kips Bay plant of New York Steam Corp.

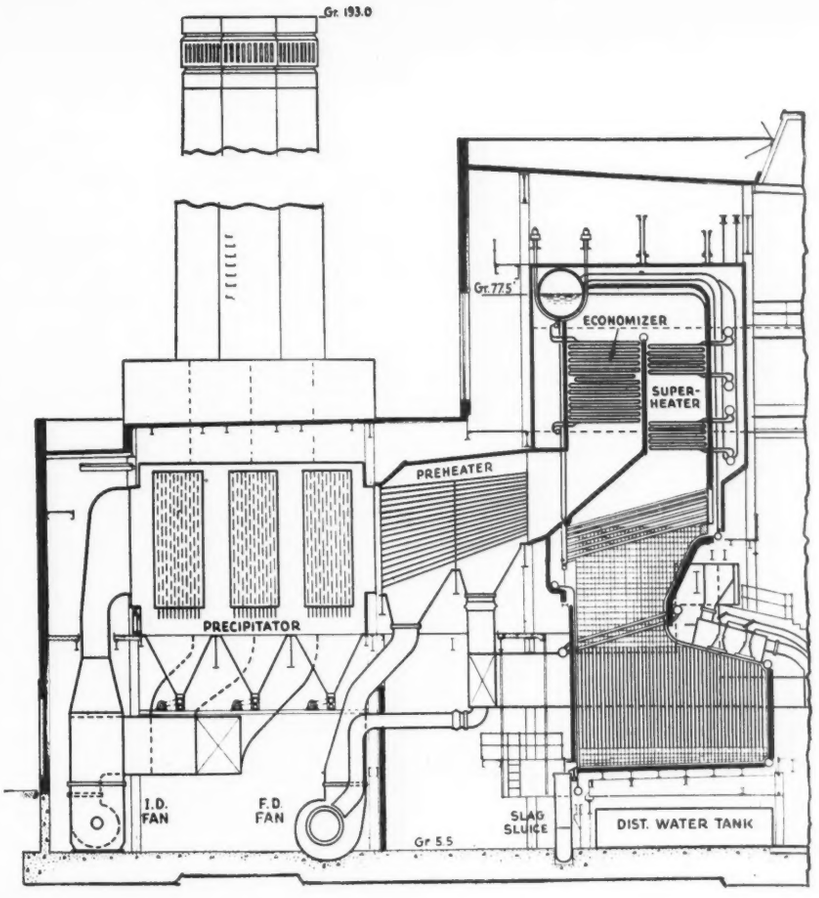


Fig. 3—Cross-section of single-pass Buzzard Point boiler

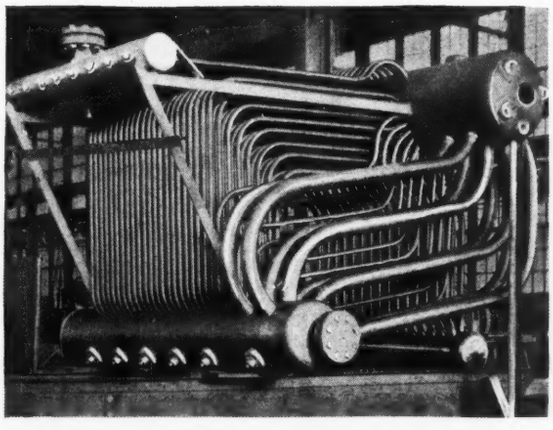


Fig. 2—Small low-head boiler for supplying process steam

To carry less than the normal low capacity of the pulverizer, as sometimes required on weekends, a system of recirculation has been designed. Return piping and valves are arranged so that the desirable quantity of coal can be recirculated to the pulverizer and only sufficient coal to carry the low load is supplied to the burner.

Pulverized-coal burners are usually lighted with portable torches. These are generally not satisfactory and frequently dangerous because of occasional flarebacks. Permanent oil torches mounted in the furnace wall below the coal burner have been developed and permit easy lighting. At the Hotel New Yorker, a lighter using gas has been developed. The gas torch is permanently installed in the burner. Gas is ignited by high-tension spark plugs, the operation of turning on the gas and spark plugs being accomplished by a single lever. Backfire of the gas is prevented by an air check valve which also prevents the burner from lighting when the draft in the furnace is insufficient.

Slag-tap furnaces continue to be favored for the larger installations of pulverized-coal fired boilers. One manufacturer reports 80 slag-tap furnaces in operation and fourteen under construction. Water-cooled bottoms are now being used for this type of furnace, as it appears to have solved the difficulty encountered with growth of the furnace floor. Specially shaped floor bricks are also used to overcome this difficulty. Results of investigations made by the U. S. Bureau of Mines show that the flow temperature of the slag decreases with increase in reduction of iron in the slag. Investigations were also made on returning fly ash to the furnace and absorbing it in the slag. It was reported that this procedure offered attractive possibilities.

Development of a tank which serves as a weigh hopper automatically filled and emptied by compressed air makes it possible to weigh pulverized coal on its way to the burner. After calibration, the number of dumps is a measure of the coal burned.

Trends in Boiler Design

The trend in the design of large boilers, both for central stations and industrial plants, is toward units having a relatively small amount of boiler heating surface followed by a large economizer section placed within the boiler setting. Boilers of this type have high steaming capacity per foot of width and are usually set over a completely water-cooled, slag-tap furnace fired ver-

tically. Furnace slag screens are usually provided to protect the upper part of the furnace from radiant heat and to collect ash and so to prevent the first row of boiler tube from clogging with slag. Central station design continues to hold to the unit system where one boiler serves one turbine generator. This was carried to its logical conclusion in a design for a plant having units of 200,000 kw., made by the New York & Queens Electric Light & Power Co. As laid out, each boiler unit is connected directly to its turbine-generator, with no interconnecting headers between boilers, thus greatly simplifying station piping and decreasing cost. Incidentally, this plant was designed as an outdoor station.

The boilers of the new Buzzard Point station are typical of the trend in boiler design. The boiler proper contains 5,488 sq.ft. of surface and is only five tubes high. The water walls contain 12,050 sq.ft. and the economizer 11,197 sq.ft. of heating surface. Designed capacity is 375,000 lb. of steam per hr. at 730 lb. pressure and 835 deg. F. As seen from the cross-section Fig. 3, a furnace slag screen is provided but is unusual in that it is covered with refractory. A water-cooled baffle, tied in with the boiler circulation, divides the upper part of the boiler into two sections, one containing a compensating superheater and the other the economizer. The economizer is connected to the boiler drum by multiple tubes instead of the usual single feed pipe. The great height between the boiler drum and the boiler tubes insures circulation.

Fig. 4—Looking up at the porcupine tubes of the Kearny mercury boiler

Superheater for Constant Steam Temperature

Higher steam temperature has centered attention upon the desirability of maintaining steam temperature constant despite wide variation in load. There are several methods of accomplishing this, such as dampers for bypassing part of the flue gas around the superheater, desuperheaters and combinations of radiant and convection superheater surface. A new method employed at Buzzard Point employs a divided superheater. In the first section, the steam temperature is raised to about 760 deg. It then is diverted into an external deheater consisting of a vertical bank of hairpin tubes immersed in water from the boiler drum. A bypass around the deheater is provided, and the amount of steam flowing through the deheater is governed by a butterfly valve in the bypass which is controlled by the temperature of the steam as it leaves the second half of the superheater. Steam made in the water space is delivered to the boiler drum.

Low-carbon steel tubes are being used in superheaters designed for steam temperatures of 850 deg. Manufacturers are prepared to furnish superheaters for 900 deg. F. For higher temperatures, alloy materials are required in at least a portion of the superheater.

A new superheater for H.R.T. boilers has been brought out. Two cast steel headers are suspended on each side of the boiler shell by adjustable clamped steel rods that pass over the top of the shell. The headers are connected by detachable tubular elements that extend around the underside of the boiler. By raising or lowering the headers, the tube elements may be raised or lowered in the combustion space, thus providing some regulation of steam temperature.

Several small, low-head, water-tube boiler designs have been brought out during the year. These have been designed to conserve space so that they can take the place of small obsolete units, but with increased capacity. They are complete units with water-cooled furnaces usually arranged for gas, oil or pulverized coal firing. Fig. 2 shows one of these units.

In high-pressure plants particularly, carryover of solids from the boilers has been a serious problem, as these solids deposit on the turbine blades, reducing capacity. Considerable headway has been made toward a solution of this difficulty by providing means in the boiler drum for washing the steam with a spray of entering feed water before it leaves the boiler. Scrubbers are provided both before and after the spray to reduce the moisture content of the steam. With this arrangement, it is possible to obtain steam leaving the boiler drum at high capacities containing less than one quarter per cent of moisture and with a solid content not exceeding 2 parts per million, providing concentration of the boiler water does not exceed 1,300 parts per million. This system has been installed in the South Amboy boilers and in the new Buzzard Point boilers.

Tube Slag-Remover Developed

Many plants have had trouble with slag adhering to the first row of boiler tubes and causing decreased boiler capacity. Cleaning off the slag is difficult and usually can be done only when load on the unit is reduced. A new device has been developed and tried which seems to

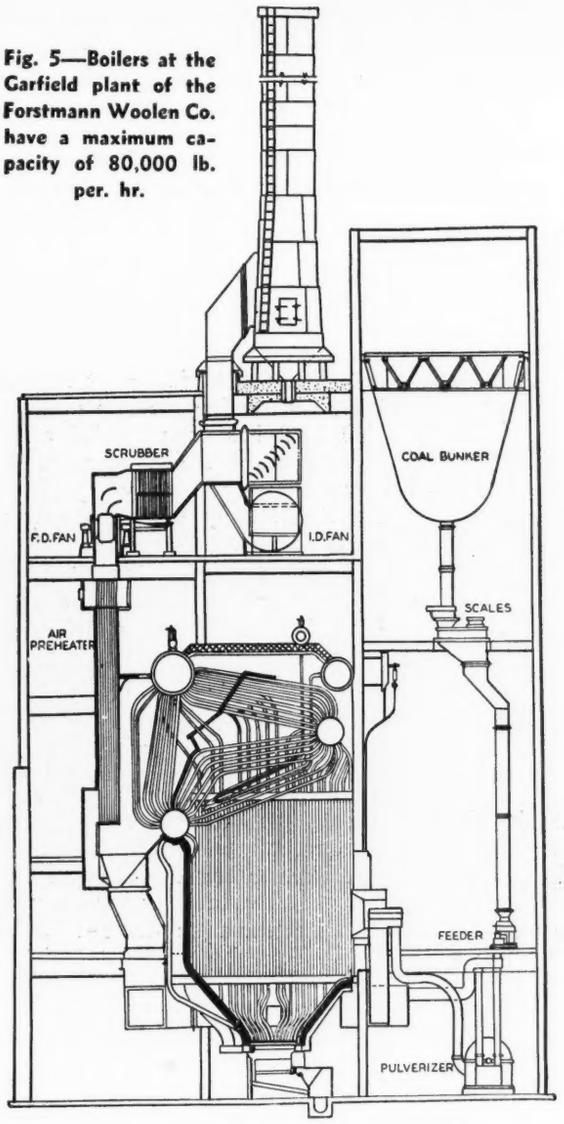


Fig. 5—Boilers at the Garfield plant of the Forstmann Woolen Co. have a maximum capacity of 80,000 lb. per. hr.

offer promise. It is somewhat like a soot-blower element, except that it is designed to spray water instead of steam on the first row of tubes. As the unit is located in the furnace, it is water cooled. The "Deslagger," as it is called, successfully removes the slag without reducing load on the boiler, and no harmful effect of the water has been reported.

Air Preheaters

Air heaters are being designed for air temperatures up to 500 deg., particularly for pulverized coal. While there have been no major changes in air heaters, improvements have been made in seal construction to reduce the amount of air leakage into the flue gas. Control of metal temperature has been obtained in some installations by recirculating varying amounts of heated air from the forced-draft ducts. This keeps the surfaces dry, preventing the accumulation of soot and decreasing the opportunity for corrosion.

Fig. 4 shows the mercury boiler furnace at Kearny which was placed in operation last year. The principal difference between the unit and the mercury boiler at South Meadow is the addition of mercury furnace walls in the upper part of the furnace. The mercury walls are made up of steel boxes, each containing three mercury tubes of $\frac{7}{8}$ in. diameter. Copper is cast in between the tubes and the walls of the box to insure an unimpeded heat flow to the mercury. The lower part of the furnace, which at present is oil fired, is provided with water walls.

During the year, distinct scientific advances were made in the field of feed-water treatment. While with one or two exceptions, these were basic and scientific rather than immediately practical, they will ultimately have great practical importance. Among these should be mentioned the work done on the solubility of sodium sulphate in concentrated boiler water salines. This research is being conducted at the U. S. Bureau of Mines under the auspices of the Joint Research Committee on Boiler Feed-Water Studies.

During the year, a sub-committee of this Joint Research Committee reported an elaborate study of the Winkler method for the determination of dissolved oxygen in boiler feed water. This work will be very helpful in perfecting the technique and reagents of this test and in determining its probable error under various conditions.

Contrasted with this basic scientific work was the announcement of a new boiler-water treatment for the U. S. Navy. Messrs. Solberg and Adams described experiments leading up to the new proposed standard Navy boiler compound consisting of anhydrous disodium phosphate, soda ash and corn starch in the proportions of 47, 44 and 9 per cent respectively. They felt that, because of the uniform nature of water contamination in Navy practice, this compound will be satisfactory for U.S.N. service. Competent engineers agree, however, that it would be a serious mistake to try to apply this compound indiscriminately in stationary practice or even in general merchant marine practice.

More Boilers Welded

For years, the American Uniform Boiler Law Society has been active in promoting uniformity and practicability in boiler legislation and particularly in promoting the acceptance of the A.S.M.E. Code as a standard for such laws. During the year, the Society found itself faced with an unusual flood of pending legislation in many states. From one to nine bills were introduced in each of fourteen or fifteen states. The October report of the Society stated that not one bill which was inimical to the best interest of the Society membership was passed, while those sponsored became law.

There was no change during the year in the number of states, territories and cities operating under the Code. At present, twenty-one states and territories operate in part or completely under the 1931 edition of the Code (with or without subsequent amendments). The list also includes seventeen cities outside of Code states. In all of these states, territories and cities, the welding of power boiler drums and tubes is permitted according to A.S.M.E. rules.

Consumer acceptance of welding is rapidly gaining as use checks the claims made for its many advantages. Additional boiler manufacturers have recognized the trend by the installation of equipment (including x-ray machines and normalizing furnaces) for meeting Code welding requirements.

TURBINES, ENGINES

Turbine developments are principally improvements. Year's largest turbine is 50,000-kw. unit for Delray. Progress made in reducing oil hazards

● NO TURBINE UNITS of outstanding capacity were ordered or placed in operation during last year. The largest put in operation was a 50,000-kw. turbine addition to Delray No. 3 plant of Detroit Edison Co., bringing capacity of that station up to 150,000 kw. The 165,000-kw. tandem unit for the Richmond station of Philadelphia Electric Co. is the largest-capacity turbine now under construction. Its high-pressure cylinder will be supplied with 375-lb., 825-deg. steam, and the double-flow low-pressure cylinder will exhaust at 29-in. vacuum. The kilowatt rating of this unit exceeds by 5,000 kw. the capacity of any previous tandem turbine, but the generator is rated at 183,333 kva., as compared to the 200,000-kva. generators at Hudson Ave. Station.

In connection with the design of this machine, extensive investigation was made of models showing steam-flow distribution in the exhaust hood and at the turbine flange connection to the condenser. The findings were of particular value because they appear characteristic of practically all exhaust chambers and because they have also aided in condenser design. A large percentage of the flow was found to concentrate around the perimeter of the exhaust, the inner portion having very low velocities.

At Buzzard Point, a new 35,000-kw. turbine was placed in operation using steam at 650 lb. pressure and 825 deg. Special provisions were made on this installation to provide against oil fires. These will be discussed in detail later in this article.

A turbine installation of special interest (placed in operation the latter part of 1933) is the 10,000-kw. 3,600-r.p.m., back-pressure unit in the Honolulu plant of Hawaiian Electric Co. This turbine receives steam at 650 lb. pressure and 825 deg., and exhausts to three older units at 265 lb. pressure. It is quite similar in design to the 18,000-kw. Burlington turbine, but is the first turbine to use a dual-fluid system for bearing lubrication and governor-valve operation. Oil is used for bearing lubrication only, and a non-inflammable fluid (Aroclor) is used for hydraulic operation of the throttle- and governor-controlled inlet valves. Reaction blading is used throughout and axial sealing strips on glands, dummies and blades.

The two 20,000-kw., double-flow mercury turbines, one at Kearny Station of Public Service Electric & Gas Co., the other in the new plant of General Electric Co. at Schenectady, have both gone into operation. Full load has been carried on the Kearny turbine (which went into operation early in last year) whereas the Schenectady unit was only recently started.

The Port Washington, Wis., 80,000-kw. tandem turbine, designed for 1,200 lb. pressure and 850 deg. steam, has been completed but is not yet in operation. Although the 150,000-kw. turbine for State Line was delivered in 1932, it has not yet been erected. Manufacture of the 120,000-kw. turbine for this same station is still held up due to deferred shipping date.

Although at the present it seems doubtful that there will be any immediate increase in the capacity of steam turbines, nevertheless one manufacturer has completed designs for a 200,000-kw. turbine to operate at 1,200 lb. pressure and 1,000 deg. F. without reheat. This may also indicate that steam temperatures will soon be increased above the present limit of 850 deg. Many believe, however, that economic reasons will cause the next step in steam temperature to be to 900 to 950 deg. rather than 1,000 deg.

10,000-Kw. Delray Unit

The 10,000-kw. turbine at Delray No. 3 plant of Detroit Edison Co. has operated 21,169 hr. on steam at 1,000 deg. On test, the unit has shown a heat rate of 10,730 B.t.u. including bleeder heaters. Turbine troubles encountered include worn shaft packing at the head end due to shaft deflection during several starting-up periods, leaking bonnet joint on the throttle valve (which was replaced with a new valve having heavier flanges), and sticking throttle valve stem due to growth of valve packing sleeves. This condition has been remedied by replacing the valve stem sleeves with steel sleeves having nitrided surfaces.

Operation of the unit is reported similar to that of units using steam of normal temperature, except that it is started with 700-deg. steam which is used until a load of 3,000-kw. is reached. Seven-hundred degree steam is also used when the unit is shut down to prevent excessive temperature strains.

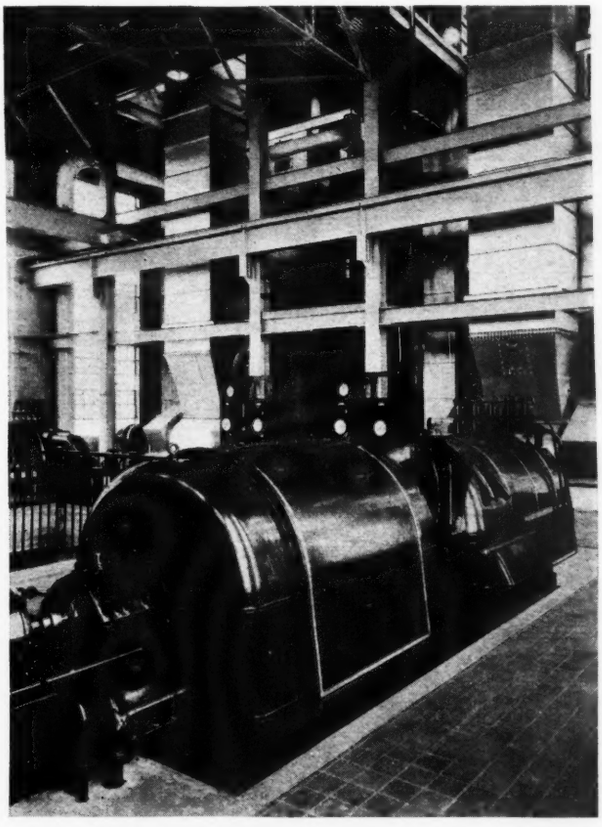
In line with the present desire for dollar economy is the coordinated design of turbine, condenser, heaters, auxiliaries and interconnecting piping. Two such units of 25,000-kw. capacity are reported under construction. This design is claimed to be economical of both space and piping.

An encouraging feature of the Prime Mover Committee report on turbines is the marked decrease in turbine outage due to blade and nozzle troubles. Outage due to these troubles decreased from 13.51 per cent in 1931 to 5.17 per cent in 1932. Outage due to wheels and spindles decreased from 4.01 per cent to 2.77 per cent in 1932. A significant change shown by outage statistics is in outage due to lubrication systems, which increased from 1.98 per cent in 1931 to 3.49 per cent in 1932. This is probably due to changes being made in existing units to increase their safety with respect to oil fires.

Oil Fires

It is probable that no other feature of turbine design has claimed so much attention as that of providing safety against oil fires. The particularly disastrous oil fire at Burlington last year served to center new attention upon this hazard. The entirely new and redesigned Burlington turbine has been placed in operation. It is provided with a dual-fluid system similar to that used in the 10,000-kw. Honolulu turbine. One other turbine is in operation with a dual-fluid system, which is also being used in the Richmond turbine now under construction.

Considerable experimentation has been in progress on the use and development of a non-inflammable lubricant. Some progress has been made. A 5,000-kw. turbine has been in operation for some time in which Aroclor is used for bearing lubrication. A great deal has been learned concerning the characteristics of this fluid for lubrication purposes, and it is hoped that the work will soon reach such a state that results may be published.



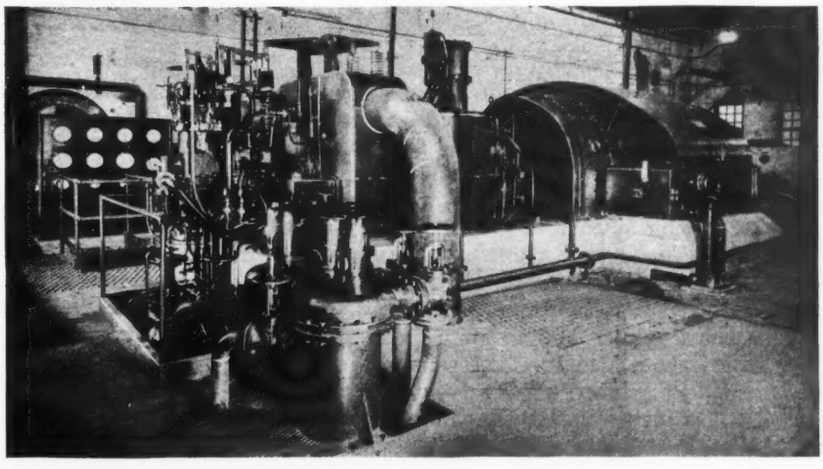
One of the 4,000-kw. turbines in the municipal plant at Piqua, Ohio

Buzzard Point Turbines

At Buzzard Point, the turbine oil equipment is entirely enclosed in a fireproof room immediately under the turbine. The oil pump, geared from the main shaft of the turbine, is located there, also the oil coolers, strainers, oil reservoir, oil purifiers and the pump part of the oil relay unit. All pressure piping to the turbine hydraulic gear and bearings, also to the three non-return valves in the extraction lines, is run inside of drain lines returning to the oil reservoir. These lines are welded. Obviously any leakage in the pressure lines cannot spurt onto hot steam pipes or accumulate in a hazardous manner. The oil room is protected with CO_2 gas automatically discharged in case of fire.

The 7,500-kw. 3,600-r.p.m. unit for the City of Austin, Texas, has been protected against oil fires by separating the steam chest and steam piping from the oil piping and oil reservoirs. This was accomplished by arranging all oil relay mechanism and oil piping on one side of the machine and the steam chest, throttle valve, and steam piping on the other side, the connection between oil relay and valves being mechanical.

In spite of the relatively small number of turbines installed during the year, active research has been carried on by the manufacturers. This has resulted in improvements to various details. A new reaction blade section has been developed, shaped to conform more nearly to an airfoil section. Tests show an improvement in efficiency over the older shape. Streamlined



The new 7,500-kw. turbine installation at the Bogalusa Paper Co.

lashing wire is now being used instead of the old round type. The new form of wire is notched to fit the inlet edge of the blade and electrically welded into place. The new lashing wire not only appears to have greater vibration strength but also has decreased the losses due to it.

Erosion of low-pressure blades still is a maintenance problem in many turbines. It is now generally recognized that satisfactory results for high blade speeds can be obtained only by protecting the back of the inlet edge with shields having a hardness of more than 500 Brinell. Stellite has been found to be about the best material for this purpose and is used by several manufacturers. Low-pressure blades so provided, it is claimed, can be operated at 1,200 ft. per sec. without more erosion than stainless steel blades operated at 900 ft. per sec.

Mechanical failure of sound turbine blades is generally attributed to vibration induced by steam forces. Recent research has shown that blade vibrations frequently are of the self-induced type and not due to resonance, and hence cannot be remedied by any tuning of frequencies. Lacking further information, blades are being designed with adequate strength even if the entire steam forces were alternating.

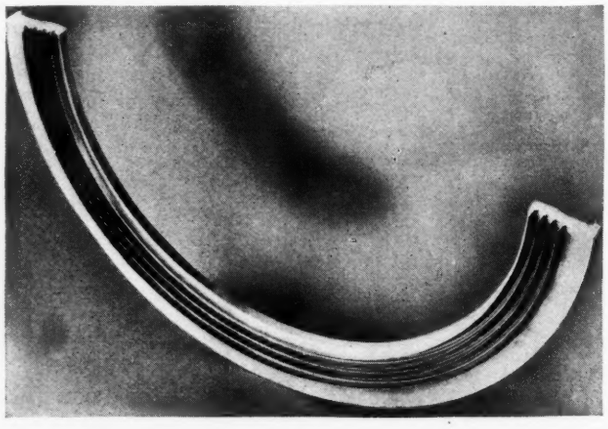
Simplified Governing

The hydraulic governing system used by one of the manufacturers only on its larger turbines has been improved and is now being applied to smaller units also. The original somewhat complicated oil impeller has been replaced by a reverse-flow impeller. Oil is pumped by an efficient centrifugal impeller of ordinary characteristics which furnishes oil for all purposes. The turbine shaft is provided with an inclined hole, one end of which terminates in a drain, the other in a chamber that is supplied with oil through an orifice. A small amount of oil is allowed to flow into the hole in the shaft so that the drain side of the hole is empty. The pressure is determined by the centrifugal force of the oil in the hole, is proportional to the square of the speed, and is used as the primary pressure in a newly developed pressure transformer. This device, as usually constructed, reverses and magnifies the pressures in the ratio of about 1 to 10. The primary or governing oil is sealed by sylphon bellows from the valve-operating oil This makes it possible to use any non-inflammable fluid in the valve-operating mechanism.

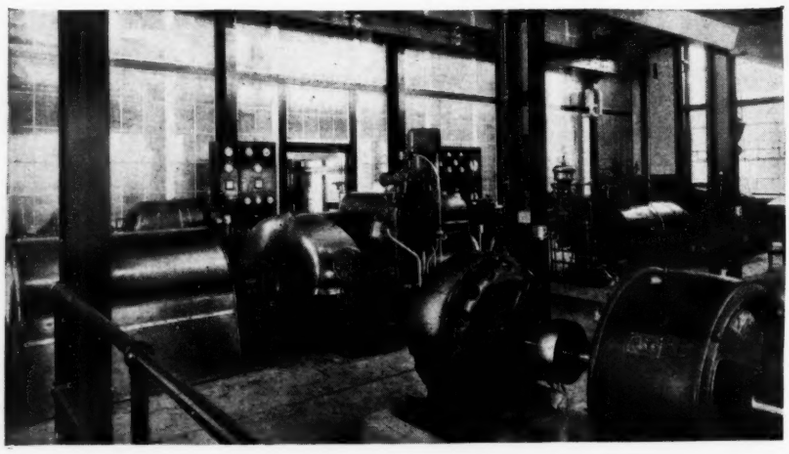
With the development of more powerful valve-operating devices, the usual balanced ported valves are giving way to single-seated plug valves which can be given desirable characteristics without porting and can be proportioned for smaller pressure drops.

New Sealing Strip

A recent sealing development for dummy pistons and high pressure glands uses thin sealing strips of chromium-molybdenum stainless steel, held in a groove by soft iron caulking strips. This arrangement makes it possible to put in the sealing strip in a single continuous piece that can be renewed when worn with little difficulty. The small dimension of the sealing strips and the physical properties of the material permit running the turbine parts in without dangerous local heating so that close clearances may be secured. The sealing strip is also being used for blade seals.



Recently developed gland and dummy seal ring



A glass partition separates turbine and boiler rooms at Forstmann Woolen's new Passaic power plant

The larger turbines are being equipped with turning devices that keep the shaft of an idle machine turning at low speed. This keeps the shaft straight, prevents rubbing and wear of packings and permits reduced starting time after short shutdown periods.

To obtain lower heat inertia, the drum-type low-pressure spindle as made by one manufacturer is being revised to a disk form of construction.

Several turbines have been ordered by industrials to operate with steam at pressures above 450 lb. One turbine builder reports that 40 per cent of the turbines sold to industrials are designed so they may be changed to operate under higher pressure and temperature at some future date.

An outstanding industrial turbine has been ordered by Goodyear Tire & Rubber Co. This 8,000-kw. unit will operate at 725 lb. pressure, 720 deg. F., and exhaust to the present low-pressure system. A large part of the flow will be extracted to the present station steam header.

Five other industrial turbines have been ordered or placed in operation during the year to operate at steam pressures above 500 lb.

A 7,500-kw. industrial turbine installed at the power plant of the Bogalusa Paper Co., operates on steam at 425 lb. pressure and 700 deg. F. It supplies process steam at a constant bleed pressure of 150 lb. and a constant exhaust pressure of 25 lb., and generates as much electrical power as the steam flowing through it will provide. This new equipment, as now operated, is saving $655 a day.

Considerable attention is being given to the distribution of steam as it enters the condenser. Tests on models of turbine exhausts have shown that high velocities exist along the periphery of the exhaust flange and large inactive areas exist in the center. By increasing the distance between the turbine exhaust flange and the tube nest, and introducing diffusers, uniform velocities can be obtained.

Welded Condenser Shells

Welded construction of condenser shells continues to increase, and in the smaller sizes cast iron has become the exception. Rolling of tubes at both ends has gained acceptance particularly with diaphragm expansion joints.

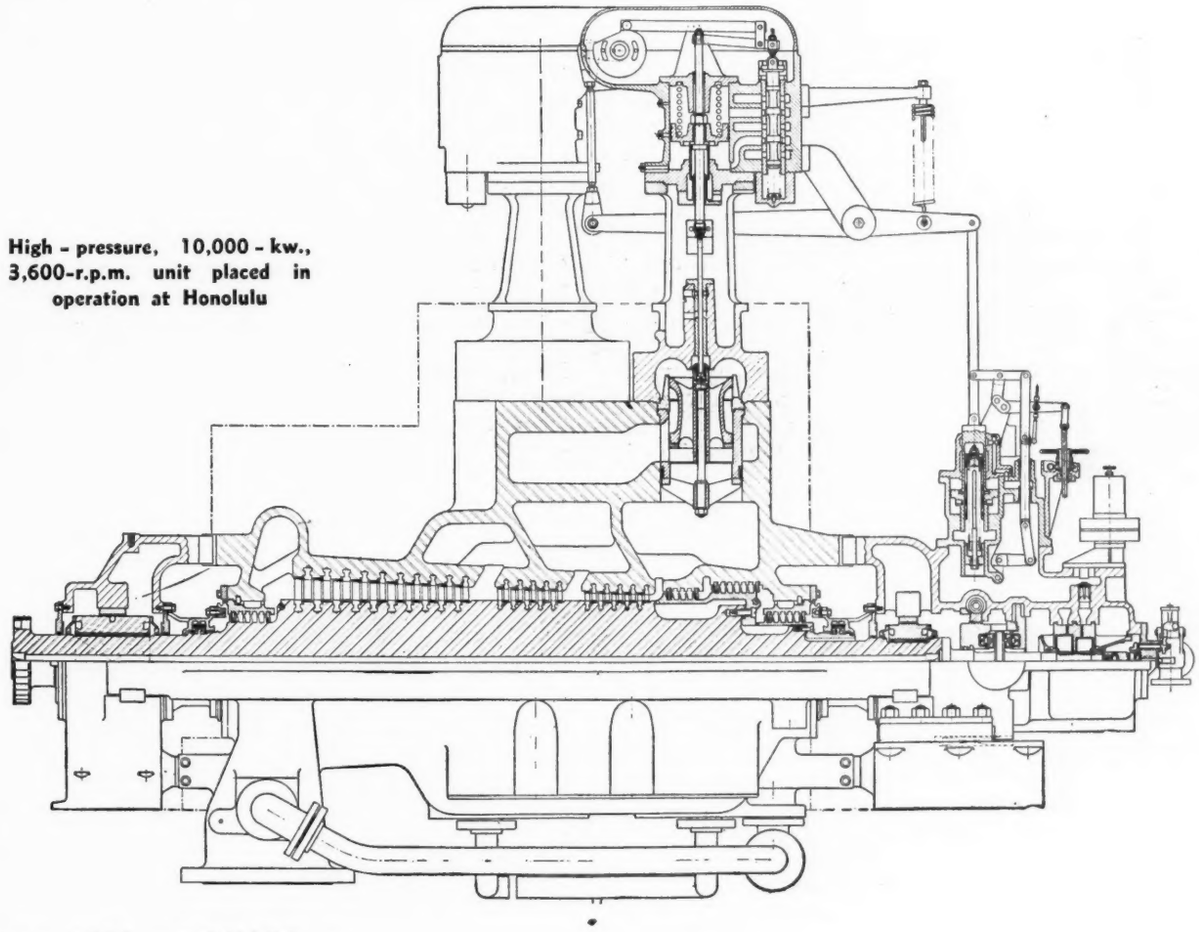
Single-pass condensers are still preferred in the larger sizes and two-pass units in the smaller sizes. This is well brought out by the equipment tabulation of new plant construction on pages 4 and 5. Practically all of the condensers are 2-pass, excepting those in central stations.

Chlorination of condenser circulating water is increasing in use. In general, those using it report improved cleanliness with no tube deterioration caused by the chlorination. An electrolytic system of condenser cleaning was installed on a large condenser and is reported to have given satisfactory results, although sufficient time has not elapsed to warrant definite conclusions.

Hudson Ave. Condensers

During the year, results of tests on the two 101,000 sq.ft. condensers at Hudson Ave. disclosed over-all heat-transfer rates of 420 to 576 B.t.u. per hr. per sq. ft. per deg. mean temperature difference, depending on load, circulating water temperatures and cleanliness. It will be recalled that these condensers are the largest surface condensers in operation. When tested, the condensers were 60 to 75 per cent clean, as determined by special test methods that have been described in *Power*.

No new developments have been observed in steam engine design or construction. Relatively few engine installations have been made, which is believed to be due largely to the decrease in institutional plant construction, as the steam engine has been particularly popular in this field.



High - pressure, 10,000 - kw., 3,600-r.p.m. unit placed in operation at Honolulu

OIL AND GAS ENGINES

1933 sees completion of country's largest engines and largest diesel station at Vernon, Calif., and largest gas engines installed at Lamoka in a combination gas engine-hydro project. Simplification, more complete enclosure, welded frames and convertible gas-diesels are outstanding design trends

● INCREASING SPEEDS, weight reduction, greater use of small engines, convertible gas-diesel units, incorporation of accessories in the engine enclosure, steel frames and other parts welded, more complete enclosure, simplification of designs, simplified control, and combinations of diesels with existing steam plants to improve heat balance—these are outstanding developments in an active year in the diesel and gas engine field.

As indicated in *Power's* Table of Diesel Installations (June, 1933), there is a definite trend toward higher engine speeds, with consequent reduction in weight per horsepower and increased difficulties with fuel and lubrication. Weight reduction is a result of greater use of welded steel and light alloys in frames, and some use of cast steel where cast iron was previously used. There is need for alloys more suitable for higher speeds and for more corrosive and erosive fuels.

The higher speeds have also added to the worries of both builders and oil suppliers in that higher-speed engines are much more sensitive to the fuel used. The fuel situation is also complicated by lack of any rational method of classification.

The inherent efficiency advantage of the diesel is being further enhanced by use of the normally wasted heat in exhaust and jacket water and by detail improvements. Several years ago, a fuel consumption of 0.5 or 0.6 lb. per b.hp. was considered good; the latest commercial engines have reduced the figure to 0.385 (Vernon) and some engines have shown 0.33-0.36 under test.

Probably the year's most striking development in the use of materials is the application of welding to frames. This type of construction has been adopted in one 2-cycle design, and several other manufacturers are doing development work along this line at the present time. Strangely enough, when the idea was first proposed four or five years ago several leading builders tried it but dropped it again because of lack of rigidity and excessive noise and vibration. These, however, are being avoided by proper placement of the metal and increasing knowledge of the art of welding. Proper design has permitted elimination of tie rods and other simplifications of design.

One crying need is a cheaper diesel, and the welded frame offers some hope. Use of welding (or of alloys) so far has resulted in reduced floor space, smaller foundations and cheaper generators because of the higher speeds developed, but has not reduced cost of the engine itself. These are of decided value to the use of a mobile diesel, but of less value to the operator of a stationary plant, unless the unit must be fitted into limited space. There should be a cost saving here due to lessened pattern cost, lower handling charges, smaller amount of metal, etc.

Most newer engine designs are almost completely enclosed, the only moving part visible being the flywheel. This is obviously advantageous, both in appearance and in lessening difficulties with dirt and danger from moving parts. Also, such enclosure has permitted installation of such auxiliaries as oil and air filters within the engine enclosure. One 4-cycle design, for example, has the air filters in the upper half of the enclosure, and has built-in fuel transfer pump, lubricating oil pump and filter and cooling water pump. Its controls are grouped at one end, simplifying the operator's job.

Combinations of diesels with steam plants frequently offer a definite economy. Several installations of this type have been made recently. Two were described in *Power* (Union Stockyards, Nov., 1932, and Marshall, Minn., Dec., 1933). Briefly the diesel takes peak loads in winter when heating steam is required, and carries the total load, or most of it, during the summer months. Thus, the inherent economy of the diesel is attained, and the low-cost by-product steam also used to the limit, while the high-cost steam generating periods are avoided.

Apparently, the greatest present need is for engines of five to a hundred horsepower for industrial, office building and store use. This is a distinct departure from former popular sizes (100 to 1,000 hp.), and so far no American manufacturer can meet the price and small-size competition. Several designs are being developed, however, and 1934 should bring forth several sound, inexpensive engines in this category.

Normally, municipalities take about 10 per cent of the engines manufactured, but last year this percentage dropped off for several reasons. Many municipalities are already overbonded for water works, sewers, sewage disposal plants and the like, and consequently cannot invest in municipal light and power plants. Thus

far, PWA allotments have been principally for these services as well, although the latest group includes three or four for diesel-driven light plants (see pages 56 and 57).

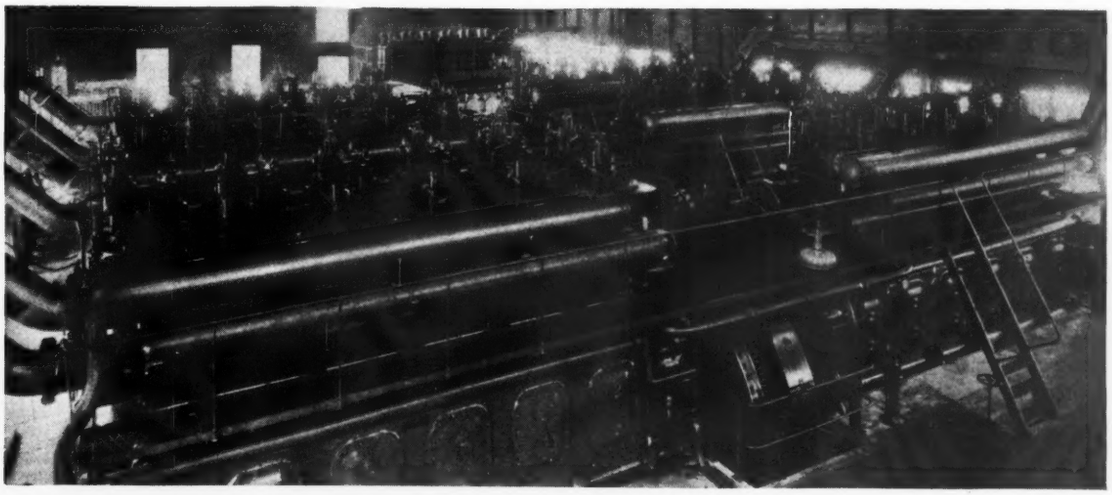
There is no avoiding the conclusion that the diesel would prove an ideal prime mover for many public utility companies, both for peak-load service and for developing isolated districts to a point where central stations would prove economical. Most utilities have, however, sufficient excess capacity for all present demands for power, therefore have not considered new units. This field may offer an increasingly important market within the next year or two, however, if the anticipated rise in business occurs. Industrial load must inevitably increase, and since utilities have worked throughout the depression to increase the domestic load, there is now insufficient capacity for full-time industrial requirements. Thus utilities will be forced to install prime mover capacity in short order—or lose the business, in which case some industrials will install diesels themselves.

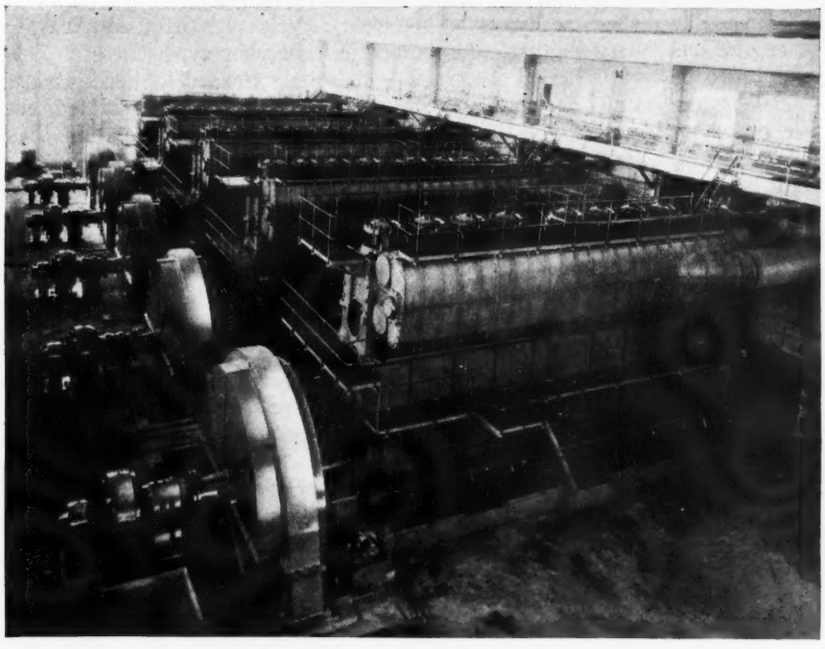
Industrials are slowly awakening to the advantages of the diesel where large quantities of process steam are not required, and are accordingly beginning to make cautious inquiries about diesel plants. The current lack of money for investment in capital goods is being overcome to some extent by installing engines on a pay-out-of-savings basis.

Some question has arisen about the wisdom of installing such a large diesel plant as that at Vernon, Calif. (*Power,* Nov., 1933) instead of a steam station. It is rumored, however, that Vernon intends eventually to use Boulder Dam power, using its diesel station as standby. Such a situation would distinctly favor the diesel plant.

Several other large diesel stations are being planned, including one in the South of approximately the same size. Possibility of a 50,000-hp. plant exists at Fort Peck, Mont., where a large irrigation project is planned by the Government. There are two possibilities for supplying the power for construction. One is a 250-mile transmission line with 0.4 cent power purchased. The other is a diesel station. Either would be junked when the project is completed. Even if the plant is junked at the end of the 3-year construction period, several estimates have placed the advantage in favor of the diesels to the tune of some $500,000.

In addition to the design developments previously





Largest U. S. Engines

At Lamoka Power Corp., three 1,800-hp. right-and-left gas engines and a 1,200-hp. unit, are installed, to operate in combination with hydro-electric units. The engines operate on sweet natural gas. Complete characteristics are given in the table on the next page. At Vernon, Calif., five 7,000-hp. double-acting diesels recently took load. This is the second largest diesel plant in the world, and includes the largest engines so far built in this country. Characteristics of the plant were listed in *Power's* June Table

Typical Gas-Engine Plants Installed in

Owner	Location	Service	Engine Builder	Horsepower	No. Engines	No. Cyl.	Cyl. Bore, in.	Cyl. Stroke, in.	R.P.M.	Single or Tandem	Horizontal or Vertical	Fuel Consumption B.t.u. per Hp.-Hr.	Type of Fuel	B.t.u. per Cu. Ft. of Fuel
Above 1,000 Hp.														
Lamoka Power Corp.	Lake Keuka, N. Y.	Gen.	Worth.	1,800	3	12	20	25	225	Rt. & Lt.	V	9,700	Natural	1,000
Lamoka Power Corp.	Lake Keuka, N. Y.	Gen.	I. R.	1,200	1	6	22	26	225	S	V	10,000	Natural	1,000
100–1,000 Hp.														
Phillips Pipe Line Co.	Syracuse, Mo.	Pump	Ster.	260	1	8	8	9	750	S	V	.....	Butane	3,200
Kettleman North Dome Assn.	Huron, Calif.	Pump	B. M.	250	1	4	14½	17	257	S	V	10,000	Natural	1,000
Arrow Drilling Co.	Tulsa, Okla.	Gen.	Wauk.	250	2	6	8½	8½	900	S	V	11,000	Natural	1,000
Freeport Sulphur Co.	New Orleans, La.	Alt.	Wauk.	250	1	6	8½	8½	900	S	V	11,000	Gaso.	12,000 per lb.
Bay Towing Co.	Galveston, Texas	Oil Pump	Wauk.	200	1	6	7	8½	900	S	V	11,000	Gaso.	12,000 per lb.
Phillips Petroleum Co.	Richmond, Kans.	Pump	Ster.	200	1	6	8	9	750	S	V	.....	Natural	1,000
Gulf Refining Co.	Neville Island, Pa.	Comp.	N. T.	180	1	1	17	24	190	S	H	9,000	Ref. Gas.	1,650
National Petroleum Co.	Titusville, Pa.	Comp.	N. T.	170	1	2	17	24	180	Twin	H	9,000	Natural	....
Heights Ice Co.	Houston, Texas	Gen., Comp.	B. M.	165	1	4	12½	15	277	S	V	10,000	Natural	1,000
			B. M.	65	1	2	11	12	327	S	V	10,000	Natural	1,000
Jaite Co.	Jaite, Ohio	Gen.	B. M.	130	1	4	11	12	327	S	V	10,000	Natural	1,000
Pilot Water Co.	Anaheim, Calif.	Pump	W. E.	120	1	2	13	20	235	Dup.	H	10,500	Natural	1,140
				80	1	1	13	20	200	S	H			
Hermosa Water Co.	Alta Loma, Calif.	Pump	W. E.	120	1	2	13	20	235	Dup.	H	10,500	Natural	1,140
Arena Mutual Irrigation Co.	Ontario, Calif.	Pump	W. E.	120	1	2	13	20	235	S	H	10,500	Natural	1,140
Stephan Ice & Bottling Co.	Bryan, Texas	Comp. & Gen.	B. M.	110	1	4	10	12	327	S	V	10,000	Natural	1,000
				55	1	2	10	12	327	S	V			
Service Ice Co.	Paris, Texas	Comp. & Alt	B. M.	110	1	4	10	12	327	S	V	10,000	Natural	1,000
Up to 100 Hp.														
Pennzoil Co.	Rouseville, Pa.	Hot-Oil Pump	N. T.	90	1	1	17	24	200	S	H	9,000	Natural	900–1150
		Hot-Oil Pump	N. T.	75	1	6	6	9	560	S	V	11,500	Natural	1600–1700
		Hot-Oil Pump	N. T.	40	1	3	6	9	600	S	V	11,500	Ref.	1,650
Garden City Ice Co.	Garden City, Texas	Comp. & Alt	B. M.	90	1	2	13½	15	277	S	V	10,000	Natural	1,000
Liebmann's Independent Ice Co.	Muskogee, Okla.	Comp. & Alt.	B. M.	90	2	2	13½	15	277	S	V	10,000	Natural	1,000
Marathon Oil Co.	Bristow, Okla.	Hot-Oil Pump	N. T.	80	2	1	17	24	170	S	H	9,000	Natural	900–1150
Conroe Ice Co.	Conroe, Texas	Comp. & Alt	B. M.	80	1	2	12½	15	277	S	V	10,000	Natural	1,000
				65	1	2	11	12	327	S	V			
Calhoun Ice Co.	Calhoun, Ga.	Integral Comp.	Worth	79	1	3	9	10½	450	S	V	9,700	Natural	1,000
Independent Ice & Refrg. Co.	Tulsa, Okla.	Comp. & Alt	B. M.	65	2	2	11	12	327	S	V	10,000	Natural	1,000
				40	1	2	8½	9	400	S	V	10,000		
Fairmount Creamery Co.	Dodge City, Kans.	Comp.	B. M.	65	1	2	11	12	327	S	V	10,000	Natural	1,000
D. M. Jones	Ardmore, Okla.	Comp. & Alt.	B. M.	65	2	2	11	12	327	S	V	10,000	Natural	1,000
Pampa Ice Mfg. Co.	Pampa, Texas	Comp. & Alt.	B. M.	65	1	2	11	12	327	S	V	10,000	Natural	1,000
Ada Ice Co.	Ada, Okla.	Comp. & Alt.	B. M.	65	2	2	11	12	327	S	V	10,000	Natural	1,000
Double Dip Ice Cream Co.	Victoria, Texas	Comp.	B. M.	55	1	2	10	12	327	S	V	10,000	Natural	1,000
Burden-Smith & Co.	Macon, Ga.	Alt.	B. M.	55	1	2	10	12	327	S	V	10,000	Natural	1,000
				40	1	2	8½	9	400	S	V	10,000	Natural	1,000
Peoples Gas Co.	Wilkinsburg, Pa.	Alt.	N. T.	54	1	4	6	9	600	S	V	11,500	Natural	1,000
Oceania Oil Co.	Signal Hill, Calif.	Pump	W. E.	50	1	1	12½	20	235	S	H	10,500	Natural	1,140
Standard Oil Co. of Kansas	East Texas	Pump Rig	N. T.	27	2	2	6	9	600	S	V	11,500	Natural	1,500

Abbreviations

Gen. —Generator; Alt.-Alternator; Comp.-Compressor.
Worth. —Worthington Pump & Machinery Corp.
I. R. —Ingersoll-Rand Company.
Ster. —Sterling Engine Co.
B. M. —Bruce-Macbeth Engine Co.
Wauk —Waukesha Motor Co.
N. T. —National Transit Pump & Machine Co.
W. E. —Western Enterprise Engine Co.
Rt. & Lt.—Right- and Left-hand
S. —Single; T—Tandem; D—Duplex.
V. —Vertical; H—Horizontal.
Gaso. —Gasoline; Ref.—Refinery.
Muff —Muffler, C. I.—Cast Iron Muffler
Ex. Hd. —Exhaust head

noted, probably the outstanding step is the convertible gas-diesel engine. A definite need for this engine has developed in those districts now serviced or soon to be served by natural gas pipelines, where one or the other fuel may suddenly become unavailable or where price differential may favor one or the other. Several makers have developed engines which can be converted by changing cylinder heads and interchanging fuel injection valves with gas-mixing valves and spark plugs. The change in the cylinder head takes care of the difference in compression pressure, and the conversion can be made in a few hours. Several foreign engines of similar type have also been developed. In addition to the cylinder head changes, some of these change compression by altering connecting rod or piston height.

One company has developed a line of engine-compressors, in which an ammonia cylinder replaces one cylinder of a 4-cyl. gas or diesel engine, utilizing the same crankshaft and frame. Economies are obvious. This same thing has been done several times before.

Two-cycle and four-cycle units still hold about the same relative positions. Two 4-cycle engine builders have developed new two-cycle lines, two 2-cycle builders 4-cycle types. One new 2-cycle unit is a crankcase-scavenging, pre-combustion chamber type.

Though the trend is definitely toward higher speeds, a 120-r.p.m., 2,850-hp. diesel was recently added at Rockville Center, L. I. Further, this engine is of the air-injection type, which was hailed as due for oblivion several years ago. There is increasing belief now that the air-injection engine is eminently suited for certain power plant conditions, and will continue to be so. Another evidence of reaction is a magnetic-spray valve, spark-ignition engine, which utilizes low compression and spark plugs, but burns diesel fuel successfully. An electrical device moves the needle valve under the force set up by the flow of an electrical charge from a condenser, instead of using the usual push rods and rocker arms. The system can be used to modify any gasoline engine to burn diesel fuel.

Among accessories, an isochronous governor and a muffler-silencer are outstanding. The governor has already been applied to several engines in service, with excellent results. It makes any diesel much more capable of maintaining synchronous speed. The muffler-silencer incorporates silencing material in its construction.

the United States During the Past Year

Compiled by E. J. TANGERMAN
Assistant Editor

Air Cleaner or Washer	Gas Cleaner or Scrubber	Lubrication Oil Cleaner	Oil Consumption, Rated Hp.-Hr. per Gal.	Cooling Water Source	Type of System	Water Inlet & Outlet Temp., deg. F.	Exhaust Temp., deg. F.	Muffler	Other Prime Mover	Waste Heat Utilized	Remarks
.....	.....	Hydroil	4,000	Penstock	Open Waste	60–120	1,000	Muff.	Gas	No	Double engine, 6 cyl. each side gen.
.....	.....	Hydroil	4,000	Penstock	Open Waste	60–120	1,000	Tank & Muff.	Gas	No	Vertical in line
.....	.....	.....	....	Wells	Waste	.....	....	Burgess	.....	.....	Rated engine hp. 360 @ 900 R.P.M.
.....	.....	.....	....	.....	.....	.....	....	.....	Gas	No	Drives thru speed increaser.
Michiana	Gravity	Cuno	....	Rain	Rad. & Fan	140–160	1,100	None	Gas	No	For oil-well drilling.
Michiana	None	Cuno	....	Well	Rad. & Fan	140–160	1,100	None	Steam	No.	General power use.
Michiana	None	Cuno	....	Well	Ht. Exch.	150–160	1,100	None	Gaso. 20 kw.	Ht. Ex.	Barge oil-pump drive.
.....	.....	.....	....	Well	Ht. Exch.	.....	....	Burgess	None	No	Rated engine hp. 270@900 R.P.M.
.....	.....	Nugent	2,000	.....	.....	.....	....	N. T.	Gas	No	Direct-connected gas compressor.
None	None	Nugent	2,000	Wells	Ht. Exch.	.....	....	N. T.	Gas	No	Repressuring old oil wells.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Hds.	.....	No	2 comp. belted one at each end, also alt.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Flat-belt to comp., V-belt to alt.
.....	.....	.....	....	.....	.....	.....	....	None	415 Gas	No	Coupled to gen. Open exhaust.
None	None	None	1,500	Pump Disch.	None	65–105	800	Western	None	No	Cooling water 20 gal. per hp.-hr.
None	None	None	1,500	Pump Disch.	None	65–105	750	Western	None	No	Cooling water 20 gal. per hp.-hr.
None	None	None	1,500	Pump Disch.	None	70–110	800	Western	None	No	Cooling water 20 gal. per hp.-hr.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Speed reducer and coupled to comp. and gen. Coupled to comp. V-belt to gen.
.....	.....	.....	....	.....	.....	.....	....	C. I.	.....	No	V-belt to 9x9 ammo. comp. one end, alt. at other
.....	.....	Nugent	2,000	Creek	.....	.....	....	N. T.	Gas	No	Horizontal Hot Oil Pump.
Air Maze	Yes	Cuno	2,000	Creek	Waste	.....	....	Oldberg	Gas	No	Horizontal Hot Oil Pump.
Air Maze	Yes	Cuno	2,000	Creek	Filter	.....	....	Oldberg	Gas	None	Vertical Triplex Hot Oil Pump.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Coupled to ammo. comp., V-belt to alt.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Coupled to ammo. comp., V-belt to comp. & alt
.....	.....	Nugent	2,000	.....	.....	.....	....	N. T.	.....	No	Horizontal Oil Pump.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Coupled to comp. & alt. Coupled to comp.
.....	.....	Cuno	....	.....	.....	.....	....	.....	.....	.....	Compressor 9 x 7½ is on same shaft.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	.....	No	Coupled to ammo. comp., one to alt. by V-belt. Drives above alt. by V-belts as required.
.....	.....	.....	....	.....	.....	.....	....	C. I.	110 Gas	No	Coupled to ammo. comp.
.....	.....	.....	....	.....	.....	.....	....	C. I. & Ex. Hds.	None	No	Comp. on one end; V-belt to alt. on other.
.....	.....	.....	....	.....	.....	.....	....	C. I.	None	No	Flat belt to ammo. comp. V-belt to alt.
.....	.....	.....	....	.....	.....	.....	....	C. I.	None	No	Comp. one end, V-belt to alt. at other.
.....	.....	.....	....	.....	.....	.....	....	C. I.	None	No	Coupled to comp
.....	.....	.....	....	.....	.....	.....	....	C. I.	None	No	Belted-type alternators.
								C. I.	None	No	
Air Maze	None	Cuno	2,000	Well	Rad.	137–160	....	.....	Gas	None	Office Bldg. power.
None	None	None	1,500	City	None	70–110	800	Western	None	No	Cooling water 20 gal. per hp.-hr.
Air Maze		Cuno	2,000	Tank	Tank	.....	....	Oldberg	None	No	Drives Parkersburg Pumping Rig.

Most of the diesel installations of note were listed in the June Table of Typical Installations. Outside Vernon, no really large installation has been made. Several engines around 1,500 hp. were installed, including the 1,450-hp. unit at Lubbock, Texas, the 1,200-hp. unit at Sioux Falls, S.D., the two engines for Greenville, Texas, which total 2,500 hp., a 3,000-hp. unit at Freeport, N. Y., and the previously mentioned 2850-hp. unit at Rockville Center, L. I.

European developments have been largely refinements in design. European builders have done much in application of sound isolation and in the use of supercharging.

The trend in marine diesels is likewise toward higher rotative speeds, higher piston speeds, reduced weight, and more use of solid-injection fuel systems. The former accepted maximum piston speed of 1,000 ft. per min. has been definitely abandoned. One European builder has reached speeds of 3,000 ft. in tests, and has built a 3-cyl., double-acting unit, developing 2,000 b.hp. per cyl., with a piston speed of 1,645 ft. per min.

Most motorships built during the past year were fitted with 2-cycle machinery, and the numerical advantage of the 4-cycle type is being rapidly overcome. The 4-cycle unit is, however, coming along for stationary service because of lower fuel and lubricating oil consumption. A new "compound admission" system increases capacity 18-20 per cent. The 4-cycle principle has been definitely abandoned for double-acting units. Mechanical or "solid" injection is becoming almost standard practice and has resulted in decided fuel economies. One maker guaranteed consumption of but 0.36 lb. per b.hp. in engines for a new cargo liner, and the engines for the "Caribia," new German motor liner, showed fuel consumption for all purposes of 0.356 lb. per b.hp. For the main engines alone, the double-acting engines of the "Caribia" showed a net consumption of only 0.33 lb. per b.hp.

The United States Navy has contracted with five diesel builders to build engines incorporating unusual features of design. These will soon be ready for shop trials. Application of diesels for motor boat and launch service are steadily increasing, and eventually all Navy launches will probably be dieselized.

Gas engines, after a long period in which their only application was in blast-furnace gas plants and in oil and gas fields, are again coming into popularity due to extension of natural-gas pipelines and availability in some industries of process gas formerly burnt under boilers. At least three new lines were announced during the year, all moderate-speed verticals, and two of the three readily convertible to solid-injection diesels. At Lamoka, three 1,800-hp. units were installed in which 900 hp. is put on each side of the generator.

PUMPED STORAGE
HYDRO-ELECTRIC PLANTS

By F. A. ANNETT
Associate Editor

Practically all pumped-storage hydro plants of the world, aggregating 1,500,000 hp. of turbines and 825,000 hp. of pump capacity, are included in this first survey and tabulation. Their economies make them well worth consideration on power systems supplied from either steam or hydro plants

● HYDRO PLANTS with water-storage facilities have well-known economic advantages when operated with stations of other types on large power systems. In many localities, particularly in certain parts of Europe, natural hydro resources are not available, or not sufficient, and water must therefore be pumped into elevated reservoirs, to be stored there until used later to provide stand-by and peak-load capacity or seasonal storage. Present increasing interest in pumped-storage hydro-electric plants prompted this survey, which covers all important present plants of the world. Most older ones are also included for their historical value.

In the table are listed plants having an aggregate capacity of 1,500,000 hp. operating wholly or in part on pumped water. For pumping, more than 825,000 hp. in pumps are installed. Of the turbine capacity, more than 900,000 hp., and of pump capacity 566,000 hp., are in Germany. The remainder is divided between Austria, Switzerland, Italy, France, Spain, Sweden, Chile and the United States. Although one of the first pumped-storage plants was built in the United States, only two important plants have been installed here.

The installations in the table have been classed as those having natural inflow into the storage reservoir (only part of the water being pumped), and those for which all water is pumped. More than 33 per cent of the turbine capacity listed operates entirely on pumped water; nearly all of this is in Germany. Of the 46 plants recorded, 16 have no natural inflow into their storage reservoirs. Most large pumped-storage plants in Germany are of that type. For example, Herdecke, the largest, with four 49,500-hp. turbines installed, operates entirely on pumped water. The pumps each require 36,000 hp. to operate them under maximum conditions. Bringhausen has four 44,500-hp. units installed and operates on pumped water only. Each of the four pumps requires 29,000 hp. to drive it. Some of the largest plants have been installed on systems where all, or a large part, of the power supply is from steam plants, the power for pumping being supplied from these plants during off-peak periods. Installations of this type include Herdecke and Niederwatha.

The plants are also classified as pondage and storage installations. Those classed as pondage type have reservoir capacity sufficient for daily or weekly storage only. Plants for which all water is pumped are of the pondage type. Bringhausen and Herdecke are examples without natural inflow into the reservoir. Bleiloch is a large-pondage project with natural inflow into the reservoir, only part of the water being pumped.

Storage-type projects are those having sufficient reservoir capacity for seasonal storage, such as Rempen (Wäggital), Fig. 1, in Switzerland, where water is pumped into storage during the summer months, when there is a surplus of water, for power generation in winter when the run-off is low.

Water may be pumped into storage under either full or part head. From the table it will be seen that in most installations water is pumped under full head, with pumps in the power-generating plant. In other installations, water is pumped under the full head of the plant immediately below the reservoir, but is used

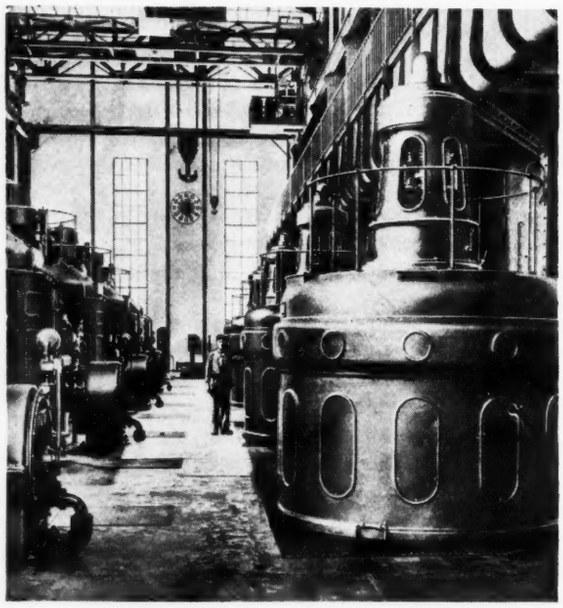


Fig. 1—Rempen plant in Switzerland is of the seasonal-storage type and has installed four 22,500-hp. turbines and four 6,500-hp. pumps

in two or more plants when released from storage. Wäggital development is a project of this type; after water passes through the Rempen plant, it is used in the Siebnen station.

In the Achental plant in Austria water is pumped under part head. The power-generating units operate under a maximum effective head of 1,312 ft., and the pumps work against a head of 650 ft., the water being taken from a location above the power house.

The Alpe Cavelli project in Italy is an interesting part-head pumping installation. There are four small motor-driven pumping plants that take water from streams below the dam and deliver it into the main reservoir. From this reservoir the water goes to two 13,600-hp. units operating under 2,300-ft. head. The maximum head on any pump is only 510 ft.

In the table, units have been classified in five general types, but these may be sub-divided according to the method of driving the pumps. In most large modern plants, a combination waterwheel, generator and pumping unit of the vertical- or horizontal-shaft type is used. The four 40,000-hp. units being installed in Lac Noir plant in France comprise an outstanding installation of combination vertical-shaft units, Fig. 3. Generators and waterwheels are standard hydro-electric units with a pump coupled rigidly to the turbine shaft. When operating as generating units, the pump

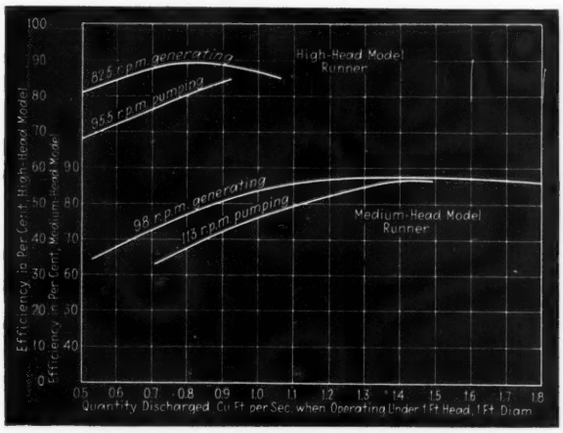

High-Head Model Runner
825 r.p.m. generating
955 r.p.m. pumping
98 r.p.m. generating
113 r.p.m. pumping
Medium-Head Model Runner
Efficiency, in Per Cent, High-Head Model
Efficiency, in Per Cent, Medium-Head Model
Quantity Discharged, Cu. Ft. per Sec. when Operating Under 1 Ft. Head, 1 Ft. Diam.

Fig. 2—Discharge-efficiency curves for two pump-turbine model runners

casings are kept free of water by compressed air. Likewise, when units operate as motor-driven pumps the turbine casings are freed of water by compressed air when the tailwater level is above the bottom of the turbine runner. The four Schluchsee vertical-shaft units, rated at 40,000 hp. each, have pumps coupled to the turbine shaft by hydraulic-mechanical-type clutches, so that during generating operation the pumps are disconnected.

The horizontal-shaft combination unit is most generally used. Fig. 4 is an elevation of a Bringhausen unit. The turbine is coupled to one end of the generator shaft. The other end connects to the pump through a hydraulic-mechanical clutch. The clutch is so designed that the pump may be connected or disconnected while the generator-motor is running at full speed.

In some horizontal-shaft, combination-unit installations pumps are geared to generators through increasing gears. For example, Schwarzenbach I unit, Fig. 5, has the generator-motor connected to increasing gears by a magnetic clutch and the gears to a pair of pumps. The waterwheels comprise three pelton runners, each with two nozzles.

Because of their high head, a maximum of 3,019 ft., the Tremorgio project pumps, Switzerland, are outstanding. There are two of them; each requires 6,400 hp. to drive it under maximum conditions, and the two are geared to the same generator-motor.

In a few installations, separate generating and pumping units are used. Two plants of this type are Rempen in Switzerland and Rocky River in the United

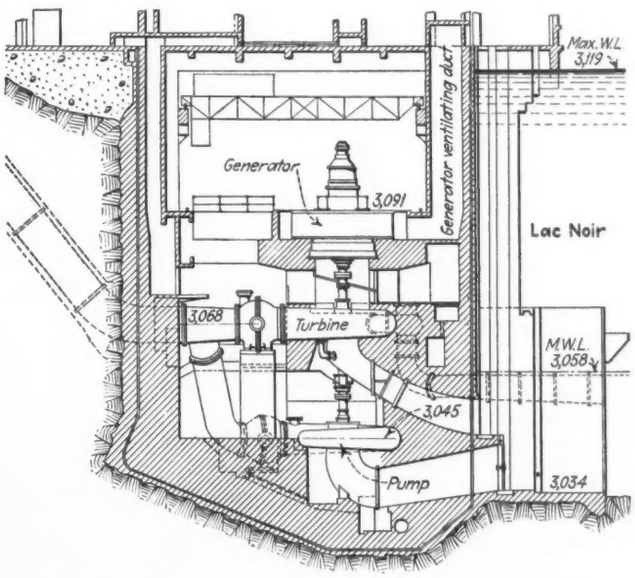


Fig. 3—Cross-section through one of the four 40,000-hp. vertical-shaft units in Lac-Noir plant, France

States. In both, all units are of the vertical-shaft type, and the developments are for seasonal storage.

Another type of installation that is being considered in Europe and the United States is that in which the hydraulic unit serves the dual purpose of both turbine and pump and the electrical unit operates either as a generator or a motor as it does on the combination units. When pumping, the unit operates at a higher speed than when generating. One such installation, Baldeney in the table, is being made in Germany. This unit is a vertical-shaft, 1,500-hp. Kaplan type, to operate under a head of from 24.3 to 29.5 ft. at 256 r.p.m. when generating and 330 r.p.m. as a pump.

Lago Baitone plant in Italy is another dual-purpose installation in which two francis-type units are used. Each generator-motor connects to two pumps that operate in parallel for heads from 16.5 to 110 ft. For higher heads, up to 210 ft., only one pump is used in each set and speed increased from 610 to 810 r.p.m. Power is generated from stored water by using one pump in each set as a waterwheel to drive the electric machines as generators. This operates over a head range of 210 down to 110 feet.

In the United States, Baldwin-Southwark engineers have, after extensive study of the problem, designed and tested two model pump-turbines. The curves, Fig. 2, represent their performance reduced to 1-ft. head operation for a runner 1 ft. in diameter at the throat. The speed given represents that for best efficiency at each operation. The two speed requirement

Pumped-Storage Water-Power

Compiled by

Power Company	Name of Project	River	[3]Type of Installation	Forebay Elev. Ft. Max.	Forebay Elev. Ft. Min.	Tailrace Elev. Ft. Max.	Tailrace Elev. Ft. Min.	Reservoir With or Without Natural Inflow	Reservoir Cap. Billion Cu. Ft.	[2]Type of Unit Installed	Number of Waterwheels Ultimate	Number of Waterwheels Installed
Germany												
J. M. Voith	Brunnenmuhle	Brenz	P.	1,921	1,959	1,596	....	Without	0.25	H. S. S. P.	1	1
U. Gminder G.m.b.H.	Neckartenzlingen	Neckar	P.	1,372	1,350	951	951	Without	0.57	H. S. S. P.	..	1
Gemeindeverband, elektrische	Fridingen	Bära	P.	2,576	2,550	2,049	2,046	Without	1.13	H. S. C. U.	..	3
Städt Elektrizitätswerk, Ueberlingen	Ueberlingen	.....	S.	1,670	1,645	1,310	1,290	With	53	H. S. S. P.	2	2
Städt Elektrizitätswerk, Tubingen	Tubingen	Neckar	P.	1,441	....	1,035	....	Without	0.233	H. C. C. U.	..	1
Gütermann & Co., Gutach	Zweribach	Zweribach	P.	3,117	....	1,542	....	With	0.233	H. S. C. U.	..	2
Badische Landes & Elektrizitäts-	Schwarzenbach I	Schwarzen-	S.	2,193	2,060	990	....	With	529.7	H. S. C. U.	..	1 1
Versorgungs A.-G	Schwarzenbach II	bach	S.	2,193	2,060	1,467	1,439	With	529.7	H. S. C. U.		1
Städt Reutlingen	Kirchentellinsfurt	Neckar	P.	1,434	1,406	1,015	1,002	Without	10.6	H. S. S. P.		1
Städt Reutlingen	Kirchentellinsfurt	Neckar	P.	1,434	1,406	1,015	1,002	Without	10.6	H. S. C. U.	..	1
Städt Elektrizitätswerk, Mittweida	Mittweida	Zschopau	P.	1,125	1,116	736	731	Without	4.6	H. S. S. P.	..	1
Städt Elektrizitätswerk, Mittweida	Mittweida	Zschopau	P.	1,125	1,116	736	731	Without	4.6	H. S. S. P.	..	1
Preussenelektra, Berlin	Hemfurth	Eder	S.	804	738	671	664	With	7,133	V. S. C. U.	..	3
Städt Elektrizitätswerk, Munchen	Leitzach	Leitzach	S.	2,146	....	1,737	1,724	With	.....	H. S. S. P.	..	1
Energieversorgung Gross-Dresden	Niederwartha	Elbe	P.	835	804	359	345	Without	67.1	H. S. C. U.	8	2
Energieversorgung Gross-Dresden	Niederwartha	Elbe	P.	835	804	359	345	Without	67.1	H. S. C. U.	..	2
Rhein.-Westf. El. A. G.	Herdecke	Ruhr	P.	855	794	320	311	Without	52.2	H. S. C. U.	4	4
Nassauische Energie-Gesellschaft	Merkenbach	Dill	P.	1,152	....	663	656	Without	0.882	H. S. C. U.	..	2
Schluchseewerk, A. G., Freidburg	Häusern	Schluchsee	S.	3,051	2,914	2,372	2,336	With	3,885	V. S. C. U.	4	2
Schluchseewerk, A. G., Freidburg	Häusern	Schluchsee	S.	3,051	2,914	2,372	2,336	With	3,885	V. S. C. U.	..	2
Preussen-Elektra, A G	Bringhausen	Eder	P.	1,662	1,612	672	661	Without	26.8	H. S. C. U.	8	4
Obere Saale, A. G	Bleiloch	Saale	S.	1,345	1,257	1,167	1,153	With	7,593	H. S. C. U.	4	4
Harzwasserwerke, A. G	Osterode	Oder	S	1,253	1,135	1,074	1,053	With	1,059	H. S. C. U.	1	1
Ruhrverband Essen	Baldeney	Ruhr	S.	170	167	146	140	With	.....	V. S. P. T.	..	1
Austria												
Stern & Hafferl, Gumnden	Gosau	Gosausee	S.	....	....	2,961	2,813	With	2,031	H. S. S. P.	2	2
Stern & Hafferl, Gumnden	Gosau	Gosausee	S.	....	....	2,961	2,813	With	2,031	H. S. S. P.	4	4
Tiroler Wasserkraftwerke	Achental	Achensee	S.	3,051	3,015	1,740	....	With	2,331	H. S. S. P.	8	2 2
Elektr. Werk, Salzberg	Hintersee	Hintersee	S.	....	....	....	....	With	238	V. S. S. P.	3	2 1
Switzerland												
.....	Zurich	.....	..	....	Hydro-Mechanical			.....	0.6	.....	..	..
E. W. Olten-Aarburg	Ruppoldingen	Aare	P.	2,353	....	....	1,326	Without	0.424	H. S. C. U.	1	1
E. W. der Stadt Schaffhausen	Schaffhausen	Rhine	P.	1,790	1,752	1,290	1,276	Without	3	H. S. C. U.	2	2
Sacid. Energie Electridque du Valais	Lake Fulley	.....	P.	6,990	....	....	....	With	113	H. S. S. P.	4	4
Illsee-Tourtemagne Power Co	Ill Lake	Tourtemagne	S.	7,680	....	....	....	With	176	.....	..	1
Aktienges. Kraftwerk, Waggital	Rempen	Aa	S.	2,953	2,805	2,105	2,074	With	5,254	V. S. S. P.	..	4
Officine Elettriche Ticinesi	Tremorgio	Tessin	S.	5,990	5,905	3,100	3,097	With	268.4	H. S. C. U.	..	1
Illsee-Turtmann, A. G	Meretschi	.....	S.	....	....	....	....	With	.....	H. S. S. P.	..	..
E. W. Olten-Aarburg	Ruppoldingen	Aare	P.	2,353	....	....	....	With	.....	H. S. C. U	..	1
France												
Soc. Elec. d'Evian Thonon	Chevenoz	Dranse	P.	....	....	....	....	Without	0.4	H. S. C. U.	..	..
Soc. d'Electrochimie et des Aciéries	Belleville	Dorinet	S.	5,656	5,397	3,973	3,967	With	1,059	H. S. C. U.	2	2
Hartmann & Fils, Münster	Münster	Fecht	P.	2,572	2,559	1,270	1,253	Without	0.636	H. S. C. U.	3	3
.....	Lake Girotte	.....	S.	5,650	....	....	4,030	With	1,000	.....	..	2
Soc. Hydro-Elec. du Midi	Lassoula	Caillaouas	S.	7,116	6,851	5,548	5,532	With	837	H. S. C. U.	3	3
Ste' Hydroelectrique des	Lac Noir	Lac Noir	P.	3,477	3,417	3,119	3,058	With	650	V. S. C. U.	..	1
Vosges, Muhlhouse	Lac Noir	Lac Noir	P.	3,477	3,417	3,119	3,058	With	650	V. S. C. U.	..	3
Italy												
Filatura Creva-Luino	Creva-Luino	Tresa	P.	....	....	....	....	Without	.....	V. S. S. P.	1	1
Soc. Elettrica Bergamasca	Clanezzo	Brembo	P.	2,297	....	851	847	Without	0.3	H. S. S. P.	1	1
Soc. Elettrica Bergamasca	Clanezzo	Brembo	P.	2,297	....	851	847	.....	.....	.....	..	1
Soc. Elettricita Alta Italia, Torino	Funghera	Stura di Viu	P.	....	....	....	....	With	1.77	H. S. C. U.	2	2
Soc. Elettricita Alta Italia, Torino	Viverone	Lakes of Viverone & Bertigrano	P.	1,242	1,211	....	....	With	10.6	H. S. C. U.	2	1
Soc. Elettricita Alta Italia	Viverone		P.	....	....	....	....	With	33.9	H. S. C. U.	..	1
Soc. Idraulica Piemontese	Promeron	Marmore	S.	7,120	7,021	....	....	With	565	H. S. S. P.	3	2
Soc. Idraulica Piemontese	Lago d. l. Torre	Sturadi Viu	S.	8,836	8,770	7,796	7,786	With	230	H. S. C. U.	2	2
Soc. Edison Di Elettricata	Alpe Cavalli I	Ovesca	S.	5,200	5,118	2,723	....	With	290	H. S. S. P.	2	1
Soc. Edison Di Elettricata	Alpe Cavalli II											
Soc. Edison Di Elettricata	Alpe Cavalli III											
Soc. Edison Di Elettricata	Alpe Cavalli IV											
Soc. Elettrica Adamello	Lago Baitone	Tozz. Remulo	S.	7,464	7,284	7,251	7,264	With	141	H. S. P. T.	2	2
S. Acciarierie e Ferriere Lombarde	Armisa	.....	S.	6,004	....	4,173	4,157	With	.....	H. S. S. P.	..	1
S. Acciarierie e Ferriere Lombarde	Zappello	Venina	S.	....	....	....	....	With	.....	H. S. C. U.	..	1
S. Acciarierie e Ferriere Lombarde	Zappello	Venina	S.	....	....	....	....	With	.....	H. S. C. U	..	1
United States	A hydro-mechanical pumped-storage pondage-type installation was made in 1885											
.....	Mill Creek No. 2	.....	P.	....	....	....	....	With	0.3	.....	..	1
Connecticut Light & Power Co	Rocky River	Rocky River	S.	430	400	200	200	With	5,900	V. S. S. P.	2	1
Lamoka Power Corp	Lake Lamoka	Keuka Lake	S.	1,099	1,096	709	700	With	200	V. S. S. P.	3	1
Chile												
Compagnia Chilena De Electricidad	Maitenes	.....	..	....	....	....	....	With	.....	H. S. C. U.	..	2
Sweden												
Royal Board of Water Falls	Sillre	Indal	S.	....	....	....	....	With	.....	V. S. C. U.	2	1
Spain												
S. A. Hydroelectrica Iberica	Urdiceto	.....	S.	....	....	....	....	.....	.....	H. S. S. P.	..	2

[1]Waterwheel Manufacturers
J. M. V.—J. M. Voith, Heidenheim
E. W. E.—Escher-Wyss Engineering Works, Zurich
M. I. —Mühlenbau und Industrie, A. G., Braunschweig
P. P. C. —Piccard, Pictet & Co., Geneva
A. d. C. —Ateliers des Charmilles, S. A., Geneva
N. B. C. —Neyret, Beylier & Co., Grenoble
C. E. F. —Constructions Electriques de France
A. R. —A. Riva, Milan
D. E. W.—De Pretto-Escher-Wyss
N. H. —Nydquist & Holm, Trollhattan
S. E. B. —Soc. Ernesto Breda, Milan
S. M. S. —S. Morgan Smith Co.
J. F. C. —James Leffel & Co.

[2]Pump Manufacturers
S. B. W. —Sulzer Brothers, Winterthur
S. B. L. —Sulzer Brothers, Ludwigshaven
J. M. V. —J. M. Voith, Heidenheim
V.-S. —Voith-Sulzer design
C. S. P. —C. C. M., Sulzer, Paris
E. W. E.—Escher Wyss Engineering Works

Developments of the World

F. A. ANNETT
Associate Editor

Waterwheel Capacity Hp.	Effective Head Ft. Speed R.P.M.	Max.	Min.	Type of Waterwheel	[1]Waterwheel Manufacturers	Number of Pumps	No. of Stages in Pumps	Capacity Sec. Ft. Speed R.P.M.	Max. Head	Min. Head	Head In Feet Max.	Min.	Pump Motor Horsepower	Water Pumped, Full or Part Head	[2]Pump Manufacturers	[4]Type of Coupling	Date of Initial Operation
290	500	318	295	Pelton	J. M. V.	2	2	1,500	2.78	3.1	335	....	160	Full	S. B. W.	.....	1908
							3	1,500	1.4	1.5	335	....	80				
600	157	421	399	Pelton	J. M. V.	2	3	1,015	5.3	.....	.....	.....	350	Full	S. B. L.	G.	1915
							4	1,130	3.5	.....	420	407	214			B.	
750	1,000	538	.....	Pelton	E. W. E.	3	3	1,000	7.06	.....	577	....	620	Full	E. W. E.	F.	1923
200	600	....	287	Pelton	E. W. E.	1	2	1,000	9.2	.....	370	....	380	Full	E. W. E.	.....	1923
600	1,000	....	307	Francis													
292	1,500	374	.....	Francis	E. W. E.	1	.	1,500	3	.....	400	....	190	Full	M. E.	F.	1924
1,250	1,000	1,575	.....	Pelton	J. M. V.	1	9	1,000	4.23	.....	1,640	....	1,055	Full	E. W. E.	F.	1925
27,500	500	1,180	1,092	Pelton	J. M. V.	2	2	1,000	29.1	53	827	594	9,900	Part	E. W. E.	G.	1925
27,500	500	1,180	1,092	Pelton	E. W. E.	2	2	1,000	29.1	53	827	594	9,990	Part	E. W. E.	G.	1925
35,000	500	1,180	1,092	Pelton	E. W. E.	1	2	500	145	205	787	623	18,850	Part	E. W. E.	H. M.	1930
900	300	22.5	20.5	Francis	E. W. E.	1	2	1,000	12.4	.....	443	....	800	Full	E. W. E.	G.	1926
2,000	1,000	394	.....	Francis	E. W. E.	1	2	1,000	23	.....	443	....	1,500	Full	E. W. E.	M.	1926
750	1,000	377	.....	Francis	E. W. E.	1	2	1,000	6.36	.....	397	....	398	Full	E. W. E.	G.	1926
1,500	1,000	377	.....	Francis	E. W. E.	1	2	1,000	12.7	.....	397	....	718	Full	E. W. E.	G.	1928
7,860	250	134	98	Francis	M. I.	2	1	250	484	618	123	75	8,000	Full	E. W. E.	F.	1928
11,000	500	410	....	Francis	E. W. E.	2	2	425	132.4	.....	427	....	8,000	Full	E. W. E.	.....	1929
30,300	375	470	396	Francis	J. M. V.	2	1	375	322	417	506	454	27,000	Full	V.-S.	F.	1928
30,300	375	470	396	Francis	E. W. E.	2	2	375	339	413	505	453	26,600	Full	E. W. E.	F.	1930
49,500	300	535	476	Francis	J. M. V.	3	2	330	459	529	535	479	36,000	Full	V.-S.	H. M.	1930
1,160	1,000	453	.....	Francis	E. W. E.	1	2	1,000	23	.....	495	....	1,620	Full	E. W. E.	F.	1930
48,700	333	623	456	Francis	J. M. V.	2	2	333	194	364	735	492	26,300	Full	V.-S.	H. M.	1930
46,000	333	623	456	Francis	E. W. E.	2	2	333	194	364	735	492	26,300	Full	E. W. E.	H. M.	1931
44,500	500	1,000	938	Francis	J. M. V.	4	2	500	196	226	1,011	945	29,000	Full	E. W. E.	H. M.	1932
29,100	176.5	190	88	Francis	J. M. V.	2	1	176.5	724	1,231	190	135	23,900	Full	V.-S.	R.	1932
								150	670	1,077	135	92	14,500				
8,700	300	200	60.7	Francis	J. M. V.	1	1	300	176	300	164	88.6	4,250	Full	V.-S.	R.	1933
1,500	256	29.5	24.3	Kaplan	E. W. E.	1	1	330	212	283	32.6	29	1,770	Full	E. W. E.	.....	1934
2,100	960	442	.....	Francis													
6,000	600	442	.....	Francis	J. M. V.	2	2	960	.....	70.6	148	....	1,430	Part	V.-S.	.....	1919
2,000	480	623	.....	Pelton	J. M. V.												
15,000	500	1,312	1,247	Pelton	J. M. V.	3	1	750	42	110	....	....	650	Part	V.-S.	F.	1928
30,600																	
2,950	500	410	345	Francis	J. M. V.	2	1	730	42	65	82	28.2	545	Part	V.-S.	.....	1931
6,000								580	34.3	53							
.....	.....	510	.....	.....	.....	2	.	.....	.....	.....	510	....	700	....	.....	.....	1892
1,200	1,200	1,017	.....	Girard	P. P. C.	1	4	1,200	4.6	.....	1,066	....	1,200	Full	S. B. W.	C.	1904
1,000	1,000	500	450	Francis	E. W. E.	2	2	1,000	10.6	12.4	560	530	1,100	Full	S. B. W.	C.	1907
3,000	.....	5,410	.....	Pelton	P. P. C.	3	7	....	7	.....	460	....	570	Part	.....	.....	1914
10,000	.....	3,230	.....	Pelton	E. W. E.	3	.	....	8	.....	360	....	1,500	Part	.....	.....	1923
22,250	500	817	666	Francis	E. W. E.	4	3	750	44.2	49.5	853	804	6,500	Full	S. B. W.	.....	1925
15,000	750	2,815	.....	Pelton	E. W. E.	2	9	1,000	14.5	.....	3,019	....	6,400	Full	E. W. E.	G	1926
.....	.....	....	.....	.....	.....	.	2	1,475	8.5	.....	360	....	450	Part	S. B. W.	C.	1926
1,960	1,000	....	805	Pelton	A. d. C.	1	4	1,000	16.2	.....	1,145	....	2,700	Full	S. B W.	.....	1927
.....	.....	1,310	.....	Pelton	.....	.	8	1,000	3	.....	1,329	....	600	Full	S. B. W.	C.	1909
4,500	1,000	....	1,640	Pelton	N. B. C.	2	6	1,000	15.5	21.9	1,739	1,476	3,800	Full	S. B. W.	C.	1920
2,100	.....	....	1,275	Pelton	.....	3	5	1,000	8.83	.....	.....	....	1,770	Full	S. B. W.	C.	1920
							6	1,450	3.07	.....	1,370	....	630				
							8	1,450	1.8	.....	.....	....	377				
.....	.....	....	1,570	Pelton	.....	2	.	....	16	.....	1,650	....	4,500	Full	.....	.....	1924
5,000	1,000	1,394	.....	Pelton	C. E. F.	3	5	1,500	21.2	.....	1,450	....	4,420	Part	C. S. P.	C.	1931
40,000	272.7	394	279	Francis	E. W. E.	1	1	272.7	213	342	427	295	16,790	Full	P. E. W.	R.	1934
40,000	272.7	394	279	Francis	E. W. E.	3	1	272.7	346	556	427	295	26,360	Full	E. W. E.	R.	1934
71	100	210	.....	Girard	.....	1	3	660	.....	.....	112	....		Part	S. B. W.	B.	1894
								915	.....	.....	210	....	71	Full		T.	
785	1,000	1,410	.....	Pelton	J. M. V.	1	5	1,500	3.53	.....	1,480	....	785	Full	S. B. W.	M. D.	1909
						1	5	1,500	3.53	.....	1,480	....	785	Full	S. B. W.	G	
1,500	600	1,410	.....	Pelton	J. M. V.	1	12	750	5.6	.....	1,480	....	1,200	Full	A. R.	T.	1923
4,000	1,000	505	440	Francis	E. W. E.	1	1	1,000	60	.....	515	455	4,000	Full	S. B. W.	C.	1909
4,000	750	492	440	Francis	A. R.	1	2	735	48.7	61.8	512	466	4,000	Full	S. B. W.	C.	1912
						1	1	980	13.2	.....	512	466	1,000	Full	S. B. W.	M. D.	1912
4,000	.....	....	.....	Francis	A. R.	2	2	735	26.5	.....	512	466	2,000	Full	A. R.	T.	1912
22,500	500	2,658	.....	Pelton	S. E. B.	2	6	980	21	.....	1,180	....	3,850	Part	A. R.	M. D.	1926
						2	6	980	7	.....	1,180	....	1,250	Part	A. R.	M. D.	1926
2,080	750	984	919	Pelton	A. R.	2	12	750	10.6	11.3	1,150	1,080	1,900	Full	A. R.	T.	1930
13,600	540-600	2,313	.....	Pelton	A. R.	2	2	810	3.9	.....	125	....	75	Part	A. R.	M. D.	1927
						3	3	810	3.5	.....	203	....	110	Part	A. R.	M. D.	1927
						2	5	810	3.5	.....	361	....	195	Part	A. R.	M. D.	1927
						3	8	810	4.2	.....	510	....	350	Part	A. R.	M. D.	1927
800	630	197	98	Francis	A. R.	2	1	610	.....	.....	.....	.....	250	Full	A. R.	M. D.	1931
								810	14.5	18.5	213	115	570				
3,450	1,000	2,494	2,362	Pelton	D. E. W.	1	10	1,240	3.53	.....	1,919	....	1,150	Part	D. E. W.	.....	1930
7,530	1,260	1,181	984	Francis	D. E. W.	2	4	1,260	12	17	1,263	984	2,560	Part	D. E. W.	C.	1932
7,530	1,260	1,181	984	Francis	D. E. W.	2	4	1,260	12	17	1,263	984	2,560	Part	E. W. E.	F.	1932
1,300	.....	1,030	.....	Pelton	.....	.	.	....	4	.....	140	....	100	Part	.....	.....	1913
33,300	200	230	200	Francis	S. M. S.	2	1	327	250	290	240	210	8,100	Full	W. P. M.	M. D.	1928
2,500		396	385	Francis	S. M. S.	1	2	1,150	17	17.8	400	390	1,000	Full	I. R.	M. D.	1932
7,500	600	396	385	Francis	J. L. C.	2	2	....	34	35.6	400	390	2,000	Full	W. P. M.	M. D.	
3,050	500	233	190	Francis	A. R.	2	1	500	49.5	72	239	197	2,100	Full	A. R.	C.	1922
10,080	600	655	525	Francis	N. H.	1	2	600	67	98.7	730	600	8,500	Full	N. H.	.....	1933
4,750	750	1,312	.....	Pelton	J. M. V.	2	5	750	17.7	22	1,440	1,345	3,750	Full	S. B. L.	M.	1923

M. E. —Maschinenfabrik Esslingen
D. E. W.—De Pretto-Escher-Wyss
A. R. —A. Riva, Milan
N. H. —Nydquist & Holm, Trollhattan
I. R. —Ingersoll-Rand Co.
W. P. M.—Worthington Pump & Machinery Corp.

[3]Type of Installation
P—Daily or weekly pondage; S—Seasonal storage.

[4]Type of Coupling
G—Gear driven; B—belt driven; F—friction clutch; M—magnetic clutch; H. M.—hydraulic mechanical clutch; T—Turbine driven; C—flexible coupling; M. D.—motor driven; R—rigid coupling.

[5]Type of Unit Installed
H. S. S. P. —Horizontal-Shaft turbine with separate pump
V. S. S. P. —Vertical-Shaft turbine with separate pump
H. S. C. U.—Horizontal-Shaft turbine and pump, combination unit
V. S. C. U.—Vertical-Shaft turbine and pump, combination unit
V. S. P. T. —Vertical-Shaft pump-turbine
H. S. P. T.—Horizontal-Shaft pump-turbine

to give as nearly as possible best efficiency can be met by a two-speed electrical unit.

The engineers of the Pennsylvania Water & Power Co. have been studying this problem, the results of which were presented in a paper by F. A. Allner before Baltimore meeting of the American Institute of Electrical Engineers, Oct. 10 to 13, 1932.

Pumped-storage plants have been built to operate under a wide range of conditions. The Rocky River installation in Connecticut provides hydro storage on a combination steam and hydro system. The storage reservoir is on a stream supplying 1.5-billion cu.ft. of water per year. The remainder of storage must be pumped from the main river, on which two other hydro plants are installed, during periods when there is an excess of hydro.

The efficiency of conversion of pumped water at Rocky River is 61 per cent—that is, for every 100 kw.-hr. delivered to the pump motors 61 kw.-hr. are returned to the busbars by the generating unit. There is a hydro plant below Rocky River through which pumped water is also used. When credit is made for this plant, every 100 kw.-hr. put into Rocky River pump motors returns 79 kw.-hr. to the power system. There are other sites for hydro development below Rocky River, which when developed will make possible a return of 111 kw.-hr. to the system for every 100 kw.-hr. put into the pump motors.

A pumped-storage plant being built by the Lamoka Power Corporation on Keuka Lake, New York State, is probably the only one of its kind in the world. A natural-gas field is under the hydro property. Gas is taken from the field to operate four gas-engine driven generators having 6,600-hp. total capacity. A hydro plant is adjacent to the gas-engine plant. One 2,500-hp. hydro-electric unit is installed; a 7,500-hp. unit is on order. One 8,000-g.p.m. pump is in service; two 16,000-g.p.m. units are on order. The hydro and gas engine plants are operated in parallel on peak loads. During off-peak periods, the gas-engine units supply power for pumping water from Keuka Lake into Lake Lamoka, the latter acting as the storage reservoir for the hydro plant.

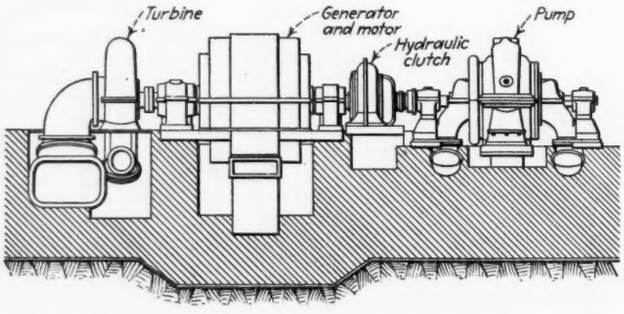


Fig. 4—One of the four horizontal-shaft 44,500-hp. units in Bringhausen plant, Germany

Mention should be made of the proposal to use a Humphrey two-cycle gas-power pump for this purpose, described on page 696 of the Mid-December number. Advantages claimed for this type of pump are low installation and operating costs.

The Sillre pumped-storage project in Sweden, which is the only one in the Scandinavian countries, shows how a plant of this kind may operate to improve the weekly load curve of other hydro plants and increase the useful power. This plant was built to operate in parallel with the Norrfors station, a run-of-river plant.

On the Indal River near the Norrfors power system are three lakes. Near one of these lakes, a head of from 655 to 525 ft. is available and is utilized in Sillre plant, where there is installed a 10,000-hp. vertical-shaft combination generating and pumping unit. During week days, Sillre plant operates generating in parallel with Norrfors station to supply system load. On Sundays and at other times when there is an excess of power at Norrfors, Sillre pumps water to storage for power generation the following week. Utilizing the natural river flow, Sillre plant can generate 20 million kilowatt-hours per year. But by pumping, the output is increased to 28 million, an increase of 40 per cent obtained at the cost of adding a pump to the installation.

Herdecke storage plant on the Ruhr River in Germany is not only the largest pumped-storage plant in operation, but also operates entirely on pumped water, and has an artificial storage reservoir. It supplies peak loads on a system, where a large part of the generating capacity is steam driven. This plant also serves as emergency reserve if one of the plants fails. Water is pumped at night from a lower into an upper reservoir, when plenty of cheap power is available from steam plants. During peak-load periods this water is used for power generation. In this plant there are four 49,500-hp. horizontal units.

The projects described are representative of some of the conditions under which pumped-storage plants are used. Those interested further in the subject should obtain a copy of a very comprehensive paper (in English), "Hydraulic Power Storage Plants," by A. Maas, Escher Wyss Engineering Works, Zurich, Switzerland. Another comprehensive paper on this subject was published in the November, 1928, *Proceedings* of the American Society of Civil Engineers under the title, "Pumped Storage Hydro-Electric Plants," by W. W. K. Freeman.

The author gratefully acknowledges the valuable assistance rendered in the preparation of this article by the Escher Wyss Engineering Works, Ltd.; J. M. Voith Company; A. Riva; Sulzer Brothers, Ltd.; Ateliers des Charmilles; and Nydquist & Holm, whose cooperation has made the table possible.

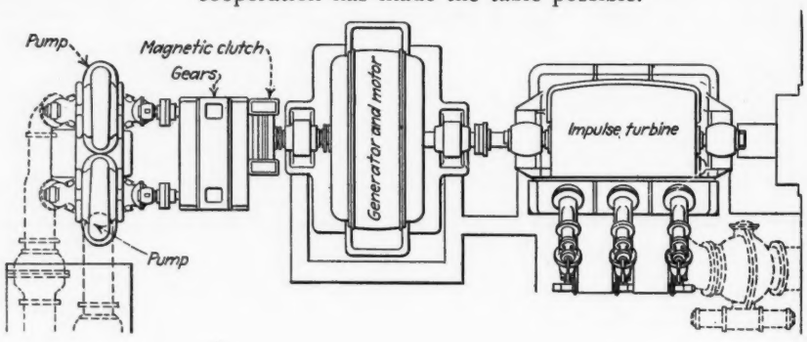


Fig. 5—Geared pumps and a 3-runner Pelton water wheel, each with two nozzles, feature two 27,500-hp. units in Schwarzenbach I plant, Germany

ADVERTISING SECTION

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Hydraulic Turbines, as a rule, operate at lower temperatures than steam turbines. Under certain conditions a lubricating oil with a low cold test is required.

For most lubricating requirements of hydraulic turbines Stanolind Turbine Oil Medium is correct. It was developed especially for this service and is being used on the majority of Standard lubricated hydraulic turbines.

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To be absolutely sure which lubricant to use for best results, we suggest you permit our lubrication engineers to study your requirements. These men have seven distinct turbine oils from which to choose the proper lubricant for your requirements.

STANDARD OIL COMPANY (INDIANA) SERVICE

NRA WE DO OUR PART

A MONUMENT TO MEN AND

POWER! What a multitude of things that word has come to mean! It replaced slaves, treadmills, candles—to become the miracle of our modern world. Thrilling as any detective story, exciting as tomorrow's newspaper—yet we men who utilize it have made it so many B.t.u.'s, so many kilowatts. We are prone to let the human, dramatic, intensely appealing story fade into the background. We say with Matthew Boulton, "I **sell** here, Sir, what all the world desires to have: **Power**!"

In this Age of Power, many names stand out. Two are Edison and Ford, one the symbol of the electric light, the other that of the automobile. We forget that these two were friends—ordinary, human, everyday pals. One has gone; the other is perpetuating his memory in an enduring monument so far in advance of our mechanical thought that only another generation will begin to appreciate its true worth.

It is difficult to conceive that the intensely practical mind of Henry Ford gave birth to buildings as beautiful as those here reproduced, and that the larger houses a great collection of steam engines of a bygone day.

Two hundred acres at Dearborn, Mich., have been set aside for an educational project which reflects the ideas of its founder, Henry Ford. Mr. Ford has named it "The Edison Institute," after Thomas A. Edison, his friend, who has been an inspiration to him and to many others in his indefatigable work for the benefit of mankind. Serving the Institute is a museum which is really a living textbook of human and technical history, intended to minister more to the student than to the curious visitor. Consequently, it houses principally distinctly utilitarian objects—pumps, bedsteads, dishes, furniture, old bicycles, early automobiles, and over a hundred early steam engines, gas engines and diesels. From these latter we have drawn seven steam plants that made history, the first designed by Thomas Newcomen and shown on page 25 of this number. The others will follow, one each month. Both the pictures and the historical data were supplied through the courtesy of the Institute and Mr. Ford.

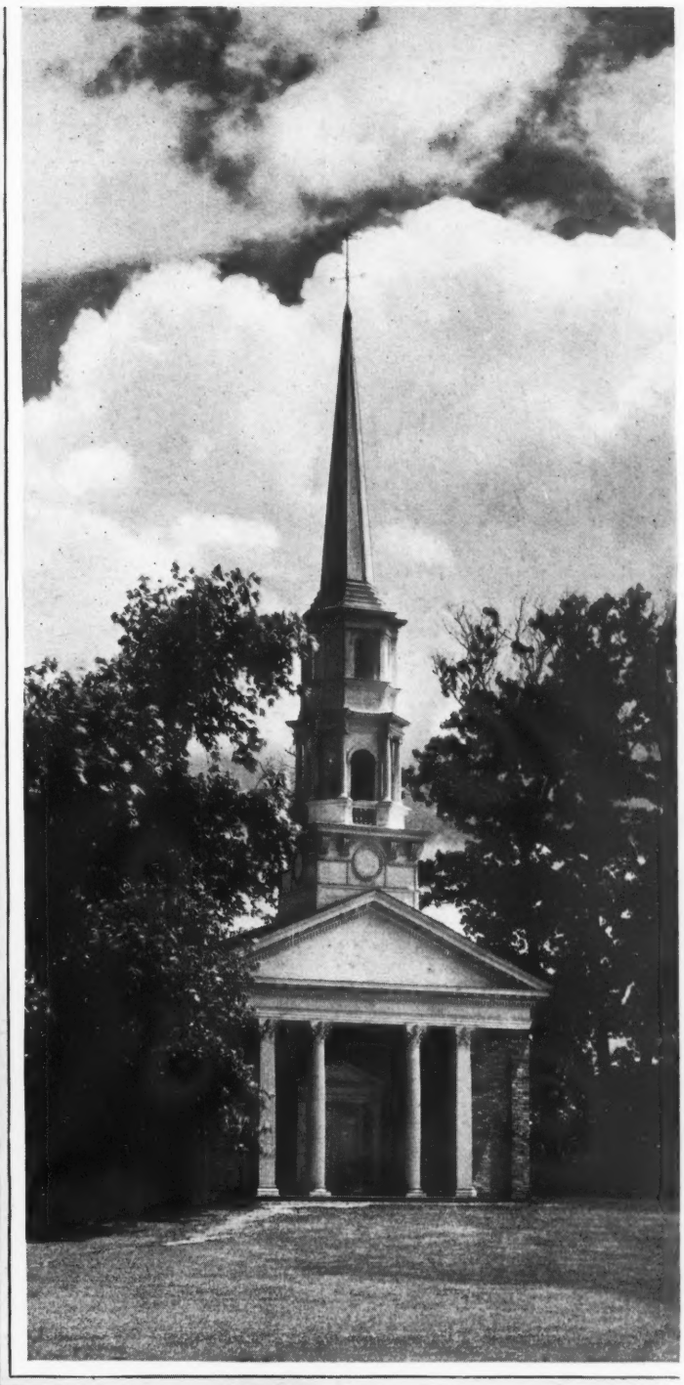
The museum building is fronted by architectural replicas (lower left) of Independence Hall, Congress Hall and the old City Hall of Philadelphia. These

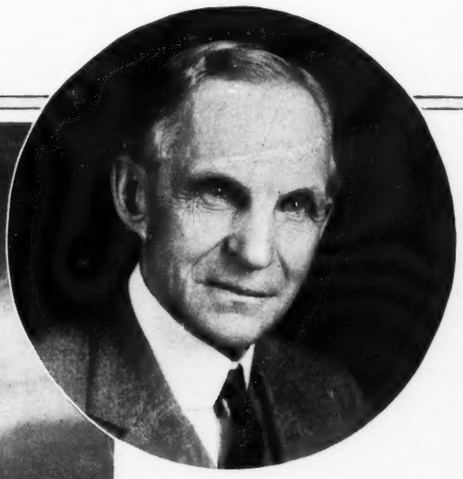
TO POWER

buildings house classrooms, workshops, libraries, auditorium and executive offices. The museum behind is one vast floor of over eight acres, upon which all the equipment is set in running order. As the exhibits are not yet completely installed, visitors are being given an opportunity to see the methods and labor involved in an undertaking of this magnitude.

Supplementary to this group and adjoining it on the east, is historical Greenfield Village. Here the handicraft arts of the past are presented as they were practiced in their original environment of public buildings and residences which in turn illustrate the development of architectural types. One example will suffice to illustrate the faithfulness and care in detail with which this work is being done. Edison's entire Menlo Park laboratories, complete with early tools, lights, even seven carloads of the very ground upon which it stood are included in the Village. Also included are the boarding house where he stayed and the "depot" where he, a lad of fifteen, was thrown off a train for his chemical experiments in the baggage car.

Through all these buildings runs the story of power—an old stone mill, a cooperage, village blacksmith shop, the original jumbo dynamo from the historic Pearl Street Station, a carding mill, first United States power silk mill, Sandwich glass plant, the old Lapeer Steam Engine Works, Armington & Sims Steam Engine Works, Loranger grist mill, old saw mill, and soy-bean extracting plant, each with its own old, old power plant. Many other buildings in the Village, each reflecting some phase of the power story, show the other facets of village life.



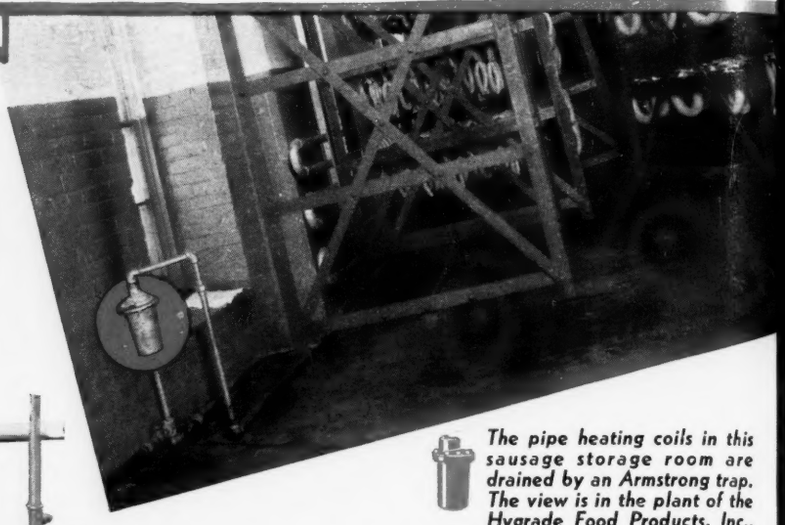


BEHIND the facade of famous Independence Hall (left) is a collection of steam engines dating back to 1760. This is the Edison Institute, conceived by Henry Ford at Dearborn, Mich. The Chapel of Martha-Mary (above) serves residents of Greenfield Village and is named after the mothers of Mr. and Mrs. Ford. Bricks and front doors are from Mrs. Ford's girlhood home, the spire is a copy of one in Bradford, Mass., and the bell was cast by a son of Paul Revere.

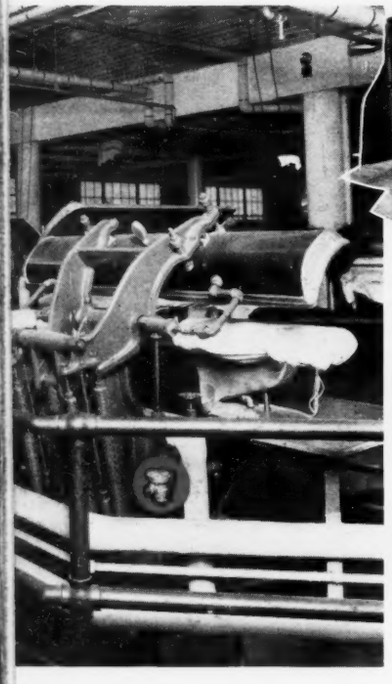
We believe this is the best

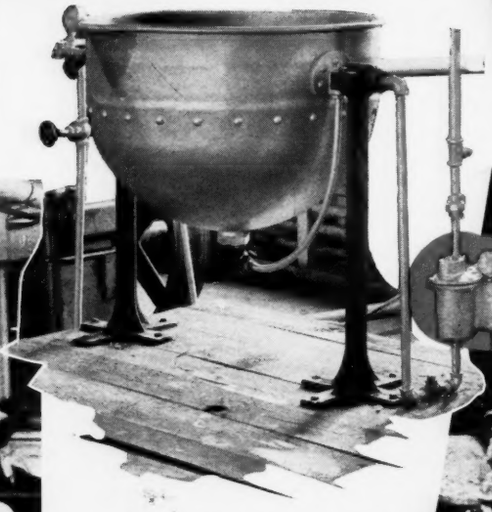
TRAP-

Each Hoffman pressing machine in this double row, operated by the Tip Top Tailors, Toronto, Ont., has its own Armstrong trap to drain condensate and air.

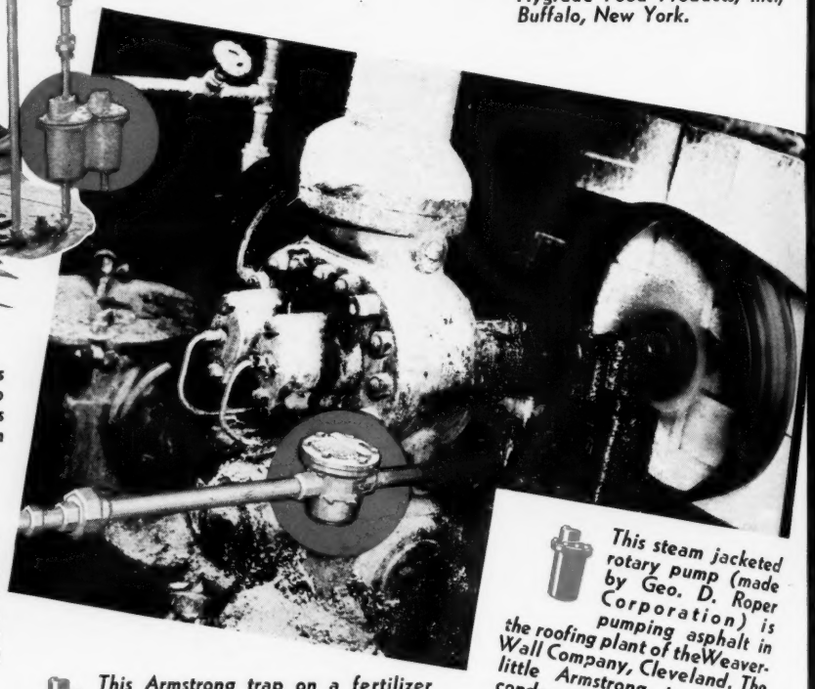


The pipe heating coils in this sausage storage room are drained by an Armstrong trap. The view is in the plant of the Hygrade Food Products, Inc., Buffalo, New York.





A thermostatic air vent in this Armstrong trap enables it to speed up operation of this jacketed kettle in a chicken canning plant.

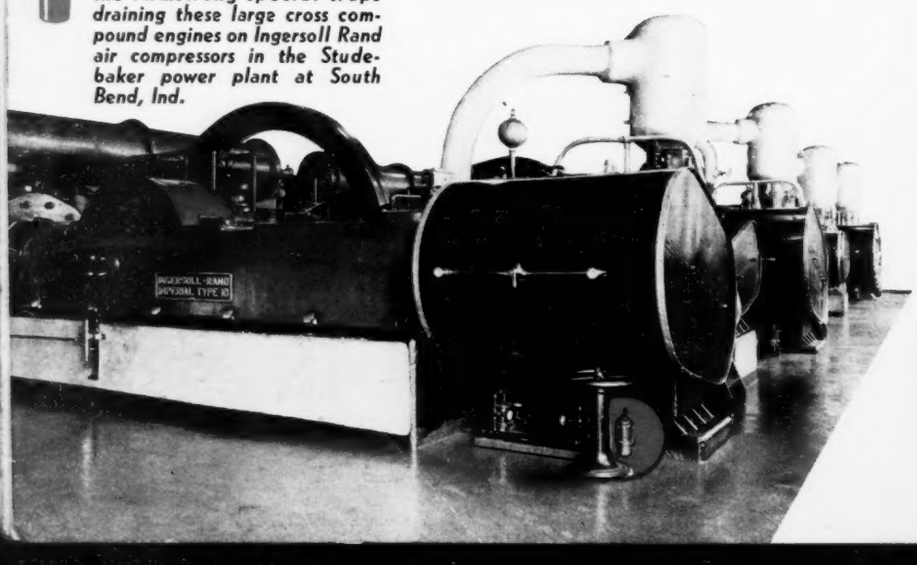


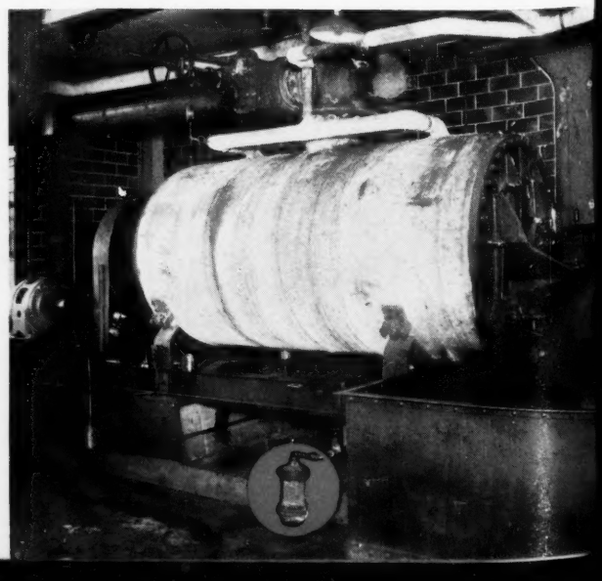
Hot presses are essential in this Chicago laundry of the Pullman Company where 130,000 pieces are handled daily—sheets, pillow cases, porters coats, etc. Armstrong traps keep air and condensate out of the steam spaces.

This steam jacketed rotary pump (made by Geo. D. Roper Corporation) is pumping asphalt in the roofing plant of the Weaver-Wall Company, Cleveland. The little Armstrong trap keeps condensate out of the steam line and the pump jacket.

This Armstrong trap on a fertilizer rendering machine—like all the others pictured on this page—was manufactured by the Armstrong Machine Works, Three Rivers, Mich.

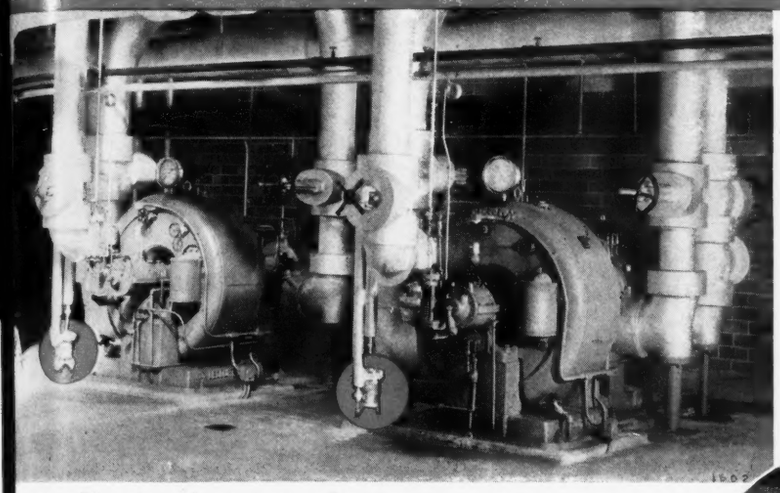
Five years service with practically no repairs is the report on the Armstrong special traps draining these large cross compound engines on Ingersoll Rand air compressors in the Studebaker power plant at South Bend, Ind.



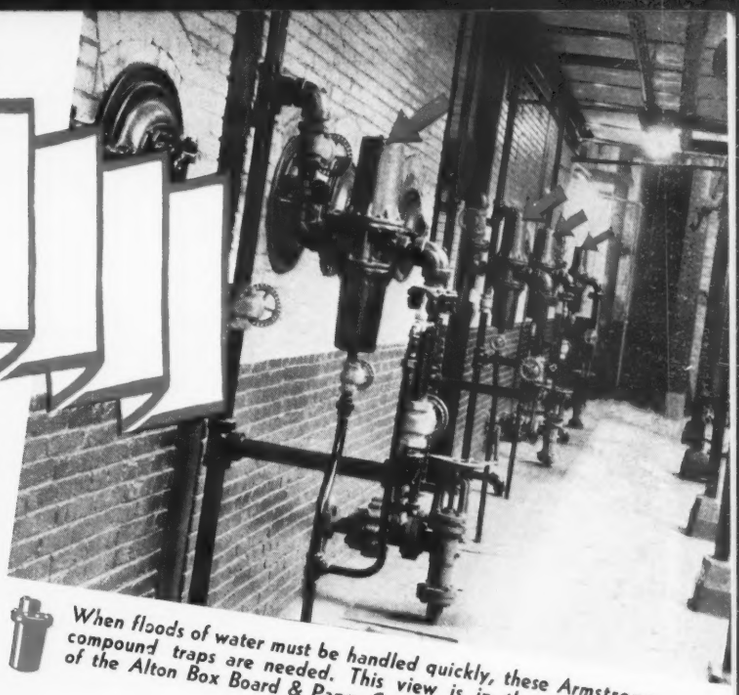


advertising for good steam traps

SHOTS

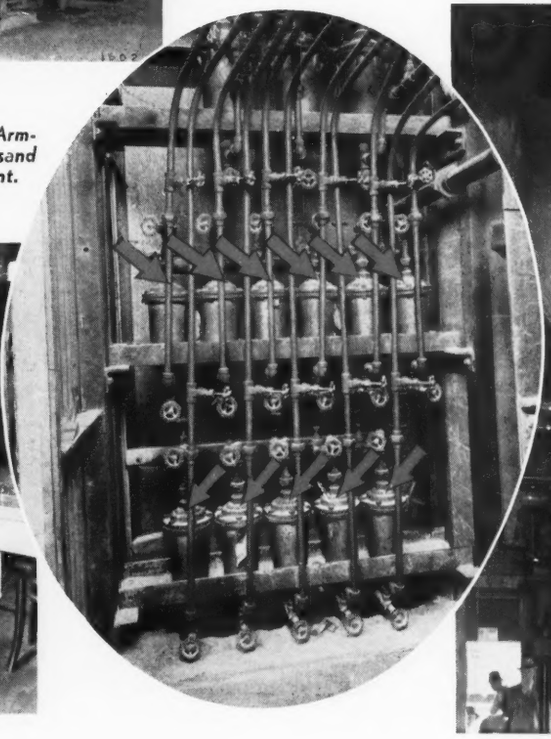


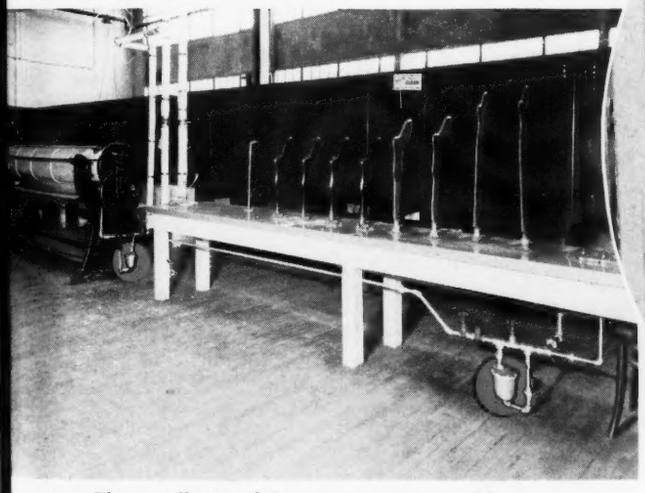
There is an Armstrong trap for every type of service. Here are forged steel traps on the Terry turbines driving boiler feed pumps in the Cleveland Electric Illuminating Company's Ashtabula, O. plant.



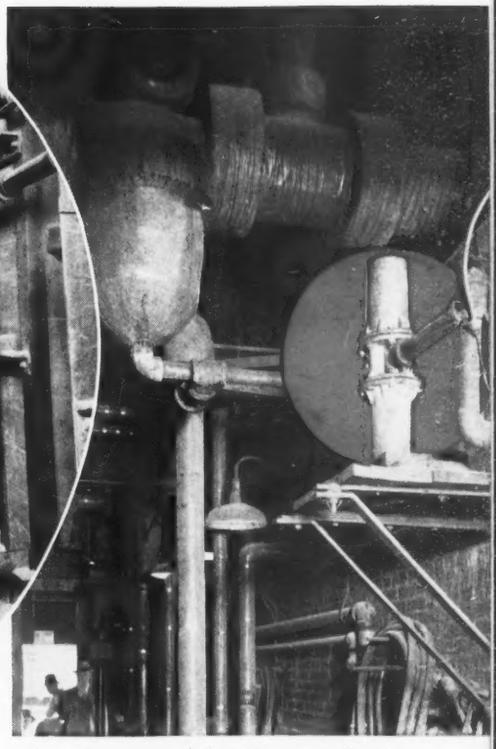
When floods of water must be handled quickly, these Armstrong compound traps are needed. This view is in the boiler room of the Alton Box Board & Paper Co., Alton, Ill.

At right: Battery of Armstrong traps draining sand dryers in a silica plant.



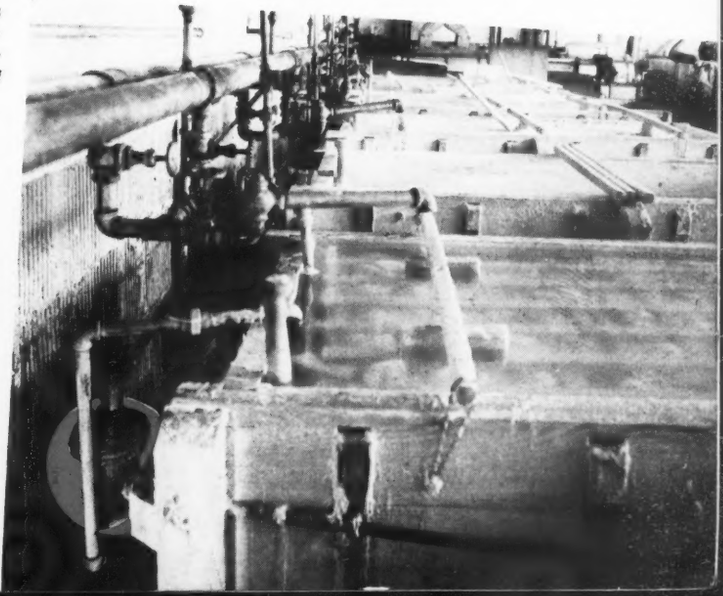


This installation of Armstrong traps on a table stocking ironer and a single roll ironer is typical of thousands of laundry applications all over the country.

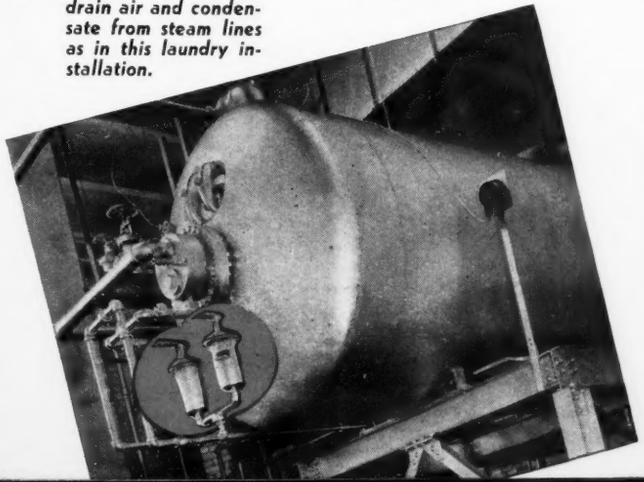


A compound Armstrong trap draining a Marley steam separator in the plant of the Forester Nace Box Co., Kansas City, Mo.

At right: Heat is supplied to these bleaching vats in the Vassar Swiss Underwear Company's plant, Chicago, through lead pipes. Condensate is removed by an Armstrong trap for each vat.



Storage type hot water heaters supply plenty of hot water when Armstrong traps drain air and condensate from steam lines as in this laundry installation.



Horsepower of Rope Drives

Chart has been calculated for cotton rope; Same values may be used for hemp and manila ropes. Pulley diameter for hemp or manila rope should be at least 25% greater.

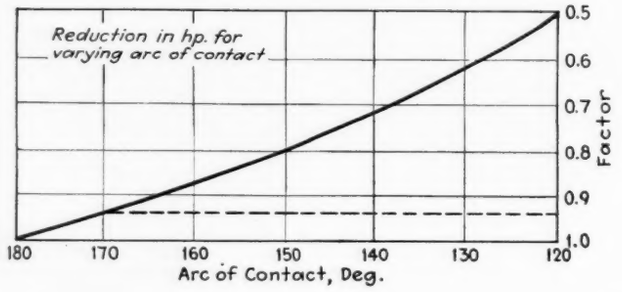
$$Hp. = \frac{VD^2}{220}\left(1 - \frac{V}{18{,}000}\right)$$

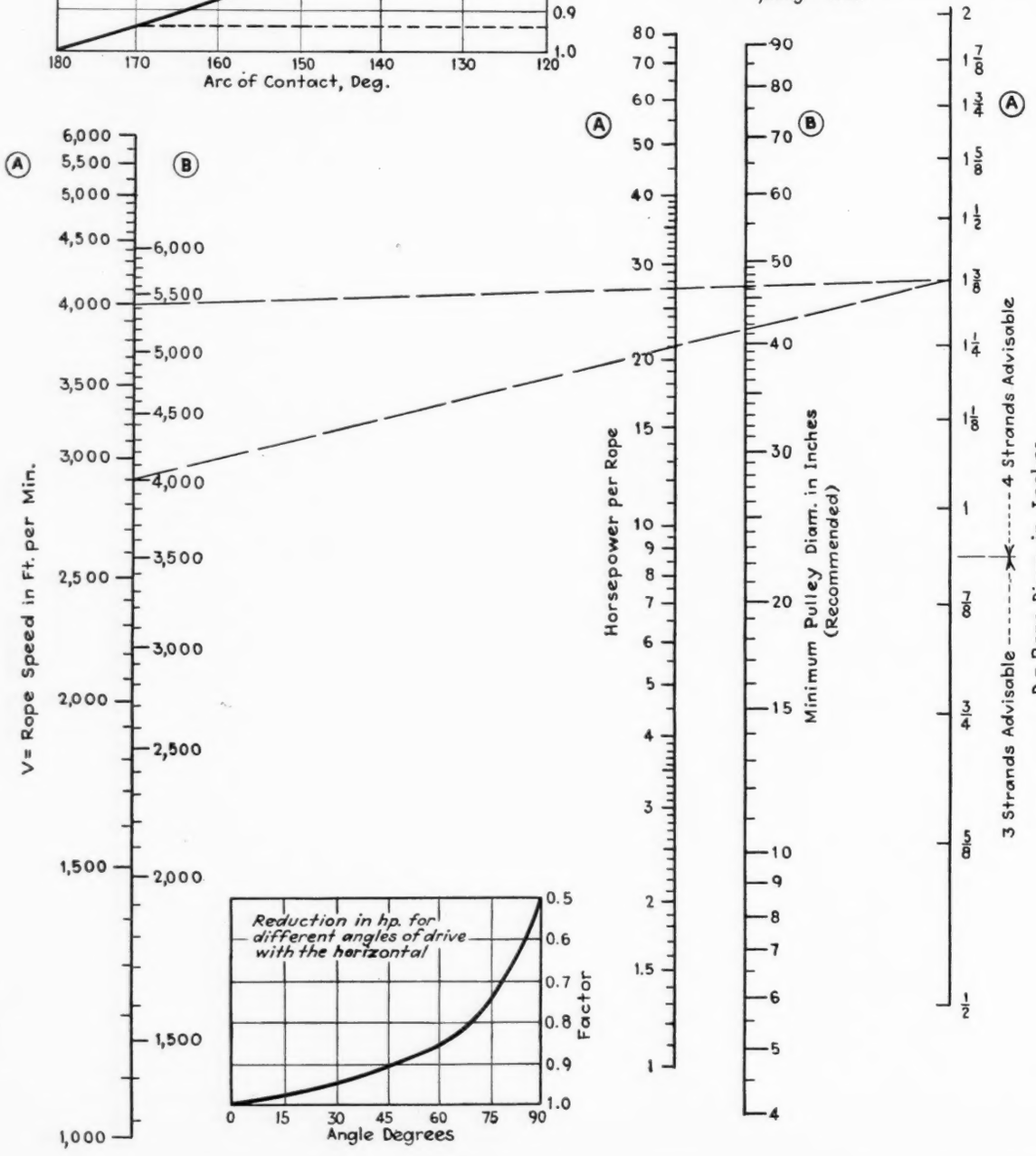
The chart allows for reduction in hp. due to centrifugal force. Reduce hp. 10% if slack side of rope is on bottom

Example: $1\frac{3}{8}$ in. cotton rope; Arc of contact 170°; Rope speed 4,000 f.p.m.; Angle of C.L. of drive with horizontal 45°

From scales **A**
Horsepower = 27
Reduction factor for arc of contact = 0.94
Reduction factor for angle of drive = 0.90
Allowable hp. = 27 × 0.94 × 0.90 = 22.8

From scales **B**
Recommended minimum diam. of pulley = 41 in.





BY E. COWAN, *Industrial Engineer*

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FOREIGN POWER

England honors Trevithick; Battersea orders 105,000-kva. unit; Dunston starts operation with 150,000 kw.; ultra-modern industrial plants; Sulzer, Benson, Loeffler and Brown Boveri boilers move ahead

● TWO POWER EVENTS of 1933 were the Scandinavian Sectional Meeting of the World Power Conference and the Trevithick Centenary in England. Pioneer in the use of "high-pressure" steam, Richard Trevithick was born on April 13, 1771, and died April 22, 1833. In 1933, the centenary of his death was celebrated by a demonstration at his birthplace in Cornwall, by memorial services at Dartford, Kent, where he died, and by special ceremonies beneath the Trevithick memorial window in Westminster Abbey.

Because of business conditions, American attendance at the sectional meeting of the World Power Conference was small. Those who could go were greatly impressed by the hospitality and beauty of the Scandinavian setting. After the official reception and opening events at Copenhagen, June 26 and 27, technical sessions were continued in the House of Parliament, Stockholm.

In Europe, as in America, few large power stations were built during 1933. Great Britain continued to make progress with its "grid" scheme of national interconnection. Under this plan, the small, inefficient plants will gradually be abandoned.

European practice as to pressures and temperatures varies widely. On the Continent, steam pressures all the way up to 3,200 lb. are used, with several installations above 1,200 lb. Steam temperatures up to 900 deg. F. are used, but 850 deg. F. is the general top limit.

With one or two exceptions, the most advanced practice in Great Britain favors 850 deg. F. and 600 lb. Several turbines that are "large," even by American standards, have recently been built. The maximum steaming capacity of individual boiler units has reached 300,000 lb. per hr.

Progress continues on large English power stations. In the great Battersea station of the London Power Company will shortly be installed a third turbine-generator. With a capacity of 105,000 kva., this will be, by far, the largest unit in England. The first two Battersea turbines were 67,200-kw. machines. Steam conditions at Battersea are 600 lb. and 850 deg. F.

During the year there went into operation the 150,000-kw. "Dunston B" station, part of the Central Electricity Board Northeast System. This plant, on the banks of the Tyne at Newcastle, contains three 50,000-kw. Parsons turbine-generators. These are tandem, 2-cyl. machines, supplied with steam at 600 lb. and 800 deg.

At Dunston, reheating has been adopted, and one of the boiler houses is equipped for pulverized-coal firing. Ultimately Dunston will house six 50,000-kw. sets.

April 6, Prince George officially opened the new Blackburn Meadows power station, supplying the City of Sheffield. At present, the new building contains one 25,000-kw., 3,000-r.p.m. turbine-generator and three boilers. Steam is supplied at 570 lb. and 770 deg. No reheating is used.

In general, the power equipment of the better American industrial plants is of more advanced design than that of corresponding plants in England. To this broad statement there are, however, notable exceptions. One is the new plant of the Dartford Paper Mills, Kent. This plant, which generates power and process steam for the Dartford Mills and also for an adjacent paper mill owned by the same firm, went into operation in May, 1933.

Three vertical-tube, 4-drum boilers, each with a maximum continuous capacity of 65,000-lb. of steam per hour, supply steam at 475-lb. pressure and 750-deg F. The combustion chamber of 3,000 cu. ft. operates at a moderate combustion rate, insuring low maintenance. Boilers are stoker fired. In addition to the chemical feed-treating system, continuous blow-down with heat exchange is used. Electricity is generated by three 750-kw. condensing turbine-alternators, bled heavily at a pressure ranging from 32 lb. to 34 lb. The turbines operate at 6,000-r.p.m., driving the 1,000-r.p.m. generators through six-to-one speed-reduction gears (following usual British practice, electricity is generated at 50 cycles).

Another interesting industrial power plant, that of the Monsanto Chemical Works, Ltd., was opened at Cefn Mawr, North Wales, in September. Steam had previously been generated at 150 lb. and 450 deg F. The chemical processes required a fairly high pressure. In order to generate by-product power from bled process steam, the new plant was designed for 425 lb. pressure and 725 deg. F. Three 3-drum boilers (capacity 25,000 lb. per hr. each) have been installed, with plate-type reheaters, but no economizers. The present tur-

bine installation consists of two 850-kw. geared bleeder units. Condenser shell is integral with the turbine exhaust casing, so that the entire unit, including condenser, rests on the turbine-room floor, no basement being required. The turbines, running at 7,500 r.p.m., drive the 50-cycle generators at 1,000 r.p.m. through a reducing gear. An automatic desuperheater controls the temperature of the bled steam and that from reducing valves.

As has been pointed out in previous reviews, European high-pressure practice inclines toward boilers of distinctly novel design rather than toward adaptation of standard types. Some of the novel boilers of previous years have, however, succeeded in maintaining their position year after year and have therefore become more or less "standard."

An interesting development is represented by the British patent recently awarded to Krupp for a method of operating the once-through-flow type of boiler. With the usual method of operation, the salts and hardness-forming constituents of the feedwater pass into the vapor in the form of a dust, which may deposit on tubes or be carried to the engines. To get around this difficulty, the patent provides for a ten per cent excess of feedwater over steam produced. The dust in solution is retained by this excess water and is finally removed with the water in a specially designed separator. The concentrated waste is passed through a heat exchanger.

The Loeffler boiler has made important strides during the last few years. The three boilers at the Trebovice power plant in Czechoslovakia are in continuous operation and the two boilers at the Heat Institute in Moscow, Russia, are nearing test. Three boilers, ordered during 1933 by "I. G. Farben" of Germany, are now being built. It is expected that the Loeffler system will make further progress in various countries during 1934.

Exhaustive tests were recently made by Prof. Josse and Prof. Miskovsky on the operation of Loeffler boilers and turbines at the Caroline Mine at Moravska Ostrava. Reports will soon be published showing a favorable picture of their behavior in operation.

Elaborate tests of the Benson boiler, installed at Langerbrugge, Belgium, were reported in the June 23, 1933, number of *The Engineer,* London. This boiler was designed for a normal output of 220,000 lb. of steam per hr. and a temporary peak output of 300,000 lb., 3,200-lb. operating pressure, 4,250-lb. maximum permissible pressure, and a steam temperature of 840 deg. F.

The boiler, standing in the open air, occupies a ground space 40 by 50 ft. and has a height of 105 ft., not including the stack. The furnace is completely surrounded by tubes wound in the form of a rectangular spiral. Firing is by pulverized coal. Ljungstrom air preheaters are used.

After some preliminary adjustments, the operation of the boiler was found to be as reliable as that of other types. In March, 1933, the boiler was in service for 538 hours and in April for 601. The acceptance test was in March. During an 8-hr. test, 84.6 per cent of the heat of the fuel was absorbed by water and steam.

As originally developed, it was intended that the Benson boiler should in all cases be used to generate steam at or above the critical pressure. Experience indicates, however, that the boiler will operate satisfactorily at lower pressures. Siemens-Schuckertwerke has developed a method of boiler and turbine operation for pressures below the critical. In this, the turbine throttle pressure is permitted to fluctuate with load, while the temperatures remain practically constant.

A detailed project had been worked out for a peak-load central station with 500-lb. normal pressure and 2,000-lb. peak pressure. The turbine output is to vary from 5,000 kw. to 20,000 kw.

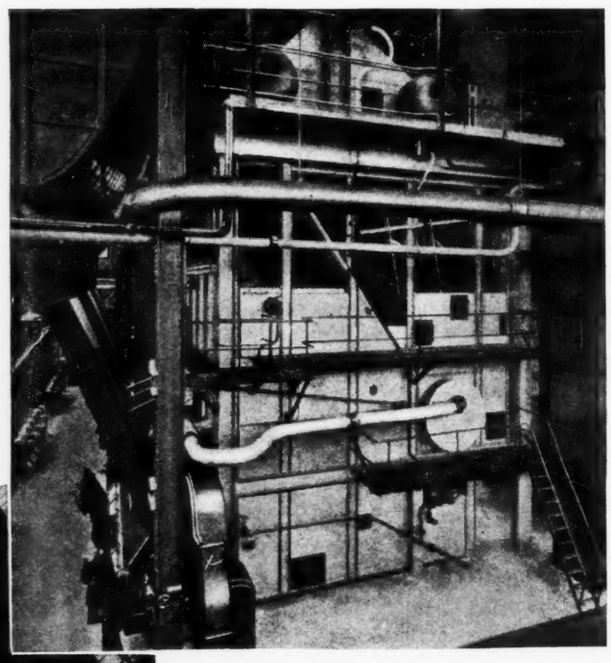


Fig. 1—New Dartford Paper Mills Plant, England, generates steam at 475 lb. and 750 deg. Turbines operate at 6,000 r.p.m. Photograph is from "The Engineer," London, Aug. 4, 1933

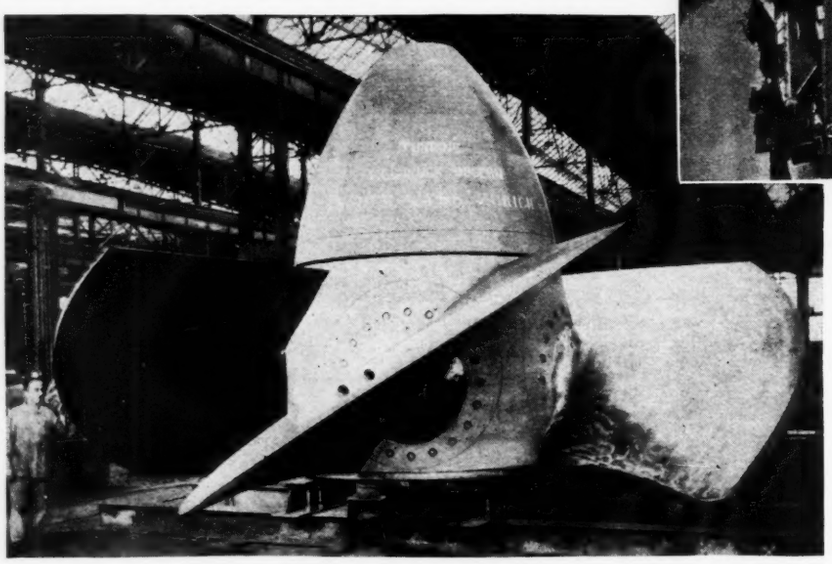


Fig. 2—Kaplan runner, 23-ft. in diameter, for one of three units in Albbruck-Dogern plant on the Rhine

In the Nov. 17 and 24 numbers of *The Engineer,* London, were reported elaborate tests by Professor A. Stodola on the Sulzer single-tube steam generator. A brief description of this remarkable boiler appeared in the February number of *Power.* As pointed out in *The Engineer,* the first commercial Sulzer single-tube steam generator was installed in the Dyeing and Bleaching Works of Charles Weber, Winterthur, and was started up in 1932. This boiler had a single tube 4,000 ft. long.

During the year Siemens built an 80,000-kva. alternator for 3,000 r.p.m., setting a new record for size in machines of this speed. The construction was made possible by the use of alloy construction, notably chrome-nickel steel forgings.

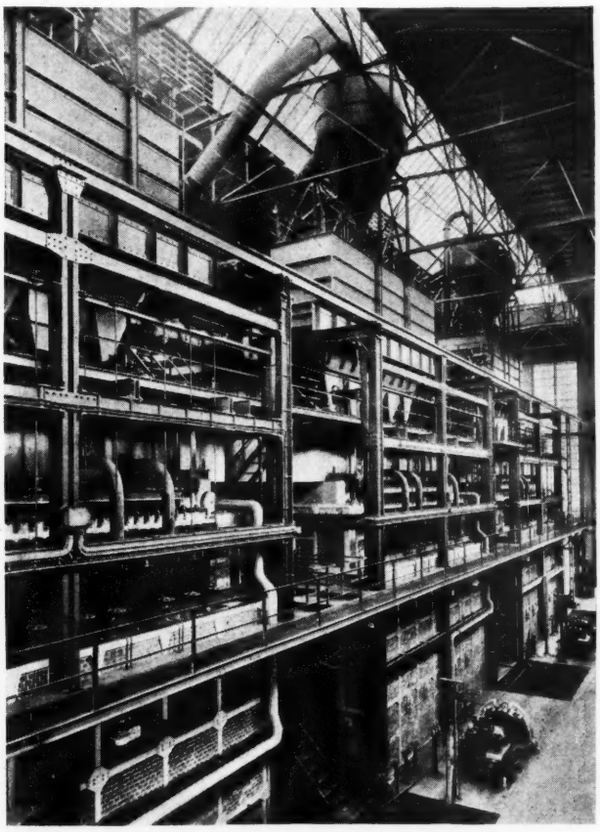


Fig. 3—Three Loeffler boilers are now in continuous operation at the Trebovice power plant in Czechoslovakia

As a decidedly original engineer, H. Barjot of Canada has come forward from time to time with novel proposals for power generation. In the Jan. 7, 1933, number of *Le Genie Civil,* he suggested the use of aluminum bromide instead of mercury in the binary-vapor cycle. This substance, he said, is non-toxic and does not dissociate below about 2,000 deg. F., nor does it attack steel. Its vapor density is 30 times that of water and twice that of mercury vapor, which makes it possible to employ slow-speed turbines.

Because of economic conditions, construction was started on very few important hydro-electric projects in Europe. Unfortunately, the Economic Conference in London accomplished minor results only and the members were unable to contribute to improving the subnormal industrial conditions. The depreciation of the most important currencies, combined with the continued increase in customs tariffs, import restrictions and transfer moratoriums very considerably impaired the already paralyzed state of export trade. This is particularly true in Switzerland where the machinery industry is primarily dependent upon exports.

Notwithstanding these obstacles, new milestones were established in the field of water-power development. The most spectacular are the 50,000-hp. units being built for the Dixence project in Switzerland, by Ateliers d. Charmilles, to operate under a maximum effective head of 5,715 ft., the gross head being 5,748 ft. The project is planned for five main units. Three are being built for the initial installation. With one unit in operation, the effective head will be 5,715 ft.

In last January's article on European power developments, mention was made of a 33,000-hp. Kaplan turbine being built by Voith for the River Shannon plant in Ireland, to operate under the record head, for a wheel of this type, of 106 ft. This year there has been reported the construction, in Switzerland, of a 7,600-hp. Kaplan runner for a head of 105 ft.

A number of interesting plants have been put into operation, and others are under construction since 1932. The Wettingen plant, on the Limmat River in Switzerland, with three Escher Wyss 10,700-hp. Kaplan turbines to operate under a 76-ft. head, went into service. These are the highest-head Kaplan turbines in operation. The Lac Noir pump-storage plant, with four 40,000-hp. vertical-shaft units, also went into service. Each unit comprises a generator, a turbine and a pump, (see cross-section, page 21, in the article on pumped-storage plants).

The Albbruck-Dogern plant on the Rhine went into service with three Kaplan turbines rated at 33,700 hp. at 75 r.p.m. under a 35-ft. head. These runners, one of which is shown in Fig. 2, are 23 ft. in diameter. Klingnau hydro-electric station on the River Aare has two Kaplan turbines of 18,600 hp. under 24.5-ft. head and is about ready for initial operation.

Two Kaplan installations under construction that are of small capacity, but merit mention, are being installed at Gundersheim and at Baldany in Germany. The former is designed to operate under a head of from 8.5 to 14 ft. and at the mean operating head will develop 3,500 hp. The Baldany unit is the first commercial installation of a Kaplan runner as a pump turbine in a pumped-storage plant. Further details of this installation will be found in the article on pumped storage plants, page 20.

In the Vargon plant, Sweden, the largest dimension Kaplan runners in the world were put into operation. There are two of these units, built by Verkstaden Kristinehamn and Nydqvist & Holm, and are rated at 15,000 hp. The runners are 26 ft. in diameter and have a discharge at full load and 14-ft. head of 11,000 sec.-ft. Features of the installation are the syphon-type settings.

In the last year's report, mention was made of the Zappello plant in Italy where two 7,500-hp. Francis turbines were being installed to operate under a head of 1,180 ft., the highest for which this type of wheel has been used. These machines are reported to have gone into service without the slightest trouble and were immediately put under load. The units operate at two different speeds, at 1,500 r.p.m. when connected to the 50-cycle system, and 1,260 r.p.m. when generating 42 cycles. These turbines operate on a pumped-storage system and further details may be had on them in the table on pages 22 and 23.

WATER POWER

New record established for hydro-electric generation in public utility plants; hydro-electric units of unprecedented size being built; the U. S. Government has launched a water-power and water-supply program in several states that involves expenditures of several hundred million dollars

● TWELVE MONTHS AGO all indicators pointed to 1933 as an off-year in water power. As measured by the number of contracts let for hydro equipment, the indicators were correct. Several milestones have, however, been established. Among these are a record for hydro-electric generation and for the size of water wheels; work has been started on several large projects that until a few months ago appeared to have little chance of being built for a long, long time.

Public utility plants in the United States generated 83,153,000,000 kw.-hr. in 1932. Of this, 41 per cent was produced in hydro-electric stations. Last year this was exceeded with a hydro-electric generation of 35,532,000,000 kw.-hr., or 41.5 per cent of the total of 85,552,000,000. In May, hydro-electric generation reached the record peak of 48.5 per cent of the total in public utility plants. Last year, hydro-electric generation was the highest on record, exceeding that in 1928, when hydro generation was 34,696,000,000 kw.-hr. in public utility plants.

Boulder Dam project, because of its size and equipment, continues to be a focal point in water power. This project is being carried forward at an unprecedented rate, with prospects of completion well ahead of schedule. The river has been diverted through four 50-ft. diversion tunnels, the cofferdams completed, and the dam, which is to be 735 ft. high, is well under way.

A field fabricating plant has been established there, by Babcock & Wilcox Co., to construct the penstocks. Penstocks for the initial development comprise about 400,000 ft. of welded steel-plate pipe ranging from 8.5 to 30 ft. in diameter and $\frac{7}{8}$ to $2\frac{3}{4}$ in. thick. One of the features of this job is the X-ray equipment provided to test the finished welds.

The two circular gates in each of four intake towers are 32 ft. in diameter, making them the largest in the world. These gates were built by Westinghouse, are of welded construction and required nearly 5,000,000 lb. of material.

The initial power installation will consist of four 115,000-hp. and one 55,000-hp. units. The plant is designed for an ultimate capacity of 1,835,000 hp. in 17 units. A contract for four large water wheels was let to Allis-Chalmers Mfg. Co. and one of 55,000-hp. was awarded to Newport News Shipbuilding Co. It is planned to start operation of the plant when the water level back of the dam has risen sufficiently to give a head on the wheels of 420 ft. At this head, the large wheels will develop 90,000 hp. They are designed for a maximum head of 590 ft., at which, with full gate, they would develop about 156,000 hp. The turbine gates are to be blocked when the head is greater than 485 ft., so that at no time will the wheels deliver more than 115,000 hp. to the generators. These turbines are the highest-power hydro units in the world and are scheduled to go into operation in 1936.

Another unit was added to Safe Harbor last year. This makes a total of five main and two service units, the former having a rating of 42,500 hp. under a head of 55 ft. The plant, which is on the Susquehanna River, is laid out for 11 units ultimately, a capacity of 510,000 hp. The turbines are of the Kaplan type, runner-blade pitch being adjusted automatically by the governor for load changes. Testing units by current meters is an outstanding feature of work done at this plant, as described in the article on meters and control, Page 36.

Installation of four initial units was completed in the Rock Island plant, Columbia River, Wash. These units are each rated at 21,000 hp.; head ranges from 20 to 51 ft. Runners are propeller type, arranged so that blade pitch may be adjusted manually while running. The units have also been tested by current meters.

Interest in water power during the past 12 months has centered in the Federal Government plan to go into the power business in several parts of the country. Outstanding is the development of the Tennessee Valley under direction of the Tennessee Valley Authority. Among activities of the Authority is the job of operating Muscle Shoals plant at Wilson Dam and selling power to municipalities and other loads at low rates. This plant has an installed capacity of 240,000 hp., with space for 610,000 hp. There is also a 60,000-kw. steam plant at Muscle Shoals. Work has been started on Cove Creek dam, now known as Norris dam on the Clinch River. This project includes a large storage reservoir and a 200,000-hp. power house, estimated to cost $34,000,000.

Work has also been started on dam No. 3 (renamed General Joe Wheeler dam) at Muscle Shoals. This dam is over one mile long and will create a 38-ft. head. The power house will provide for 250,000 hp.

Just what may be the outcome of the Government's experiment in the Tennessee Valley no one can predict. There are rumblings to the effect that other dams may be built, among them one at Aurora Landing in Kentucky, another at Chickamauga Creek, just above Chattanooga. One thing seems certain, namely, that there will be no private development on the Tennessee River (see map).

Two large power projects have been started on the Columbia River. An appropriation of $20,000,000 has been made for the Bonneville development, at tidewater, about 40 mi. east of Portland, Ore. Total cost of the project is estimated at $31,000,000. The dam will be about one mile long and the power-house structure will provide for ten to twelve 60,000-hp. propeller-type units, two included in the initial development.

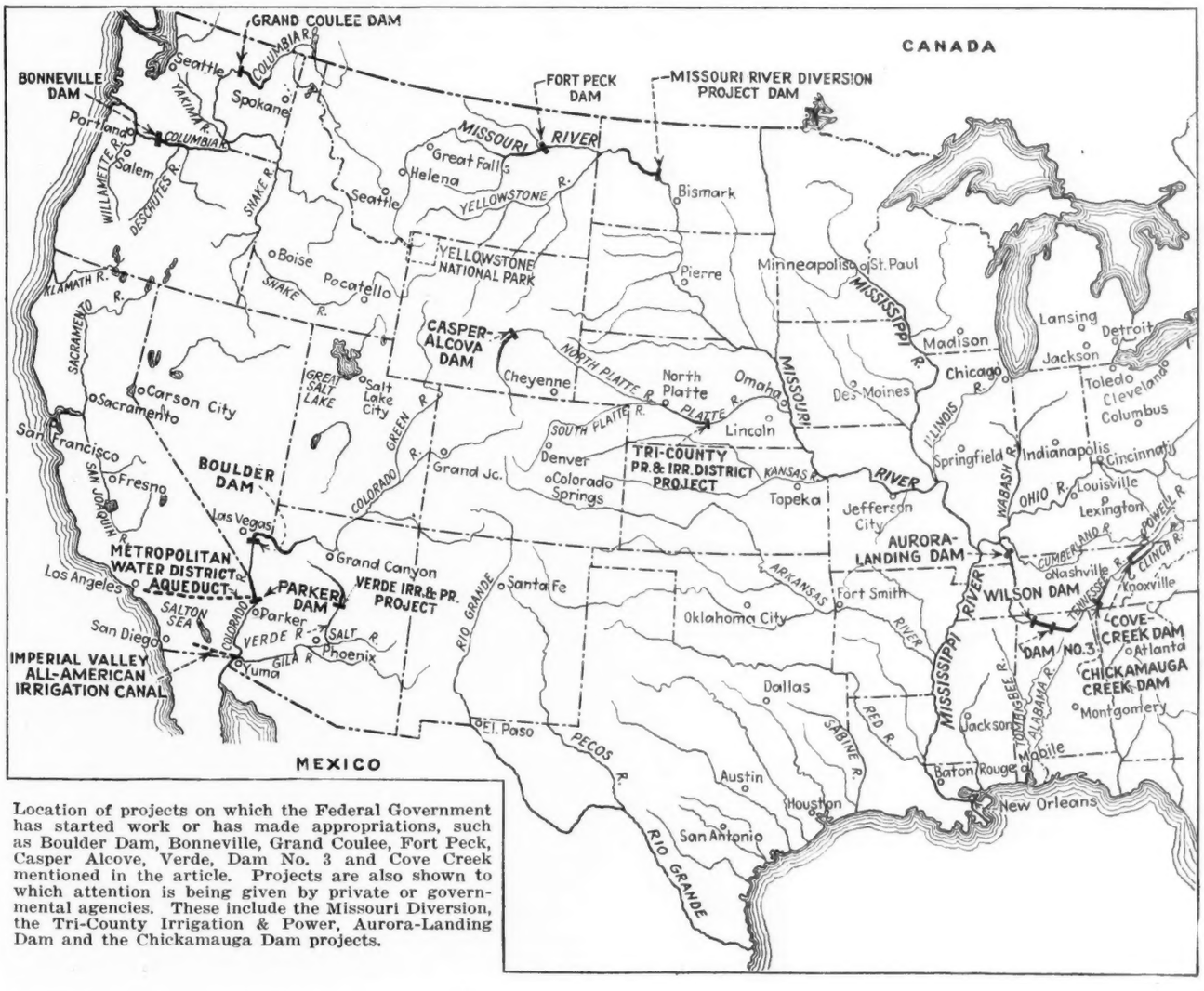
Work has also been started on the Grand Coulee irrigation, power and river-control project on Columbia River. This project, as originally planned, included a dam 370 ft. high and a power development of over 2,100,000 hp. and was estimated to cost $160,000,000. A modified project is being built with a dam 145 ft. high and a power development for about 700,000 hp. at an estimated cost of $63,000,000. The foundation, however, will support a dam 370 ft. high.

A Federal allotment of $22,700,000 has been made for Casper-Alcova, a Federal reclamation project in Wyoming on the North Platte River. Work has been started on Fort Peck dam on the Missouri River in eastern Montana, a $25,000,000 Federal allotment having been made. This is an irrigation project and includes an earth dam 230 ft. high to create a reservoir of 17,000,000 acre-feet. Other power and irrigation projects are also being financed in the western states by the Federal Government as a part of its recovery program, one of these being the Verde irrigation and power development, with a Federal appropriation of $4,000,000.

At this time, many obstacles are still to be cleared before work can start on the International section of the St. Lawrence River, nevertheless, under stimulus of the Federal Government recovery program, anything may happen. During the last session of Congress, the House passed a resolution awarding all United States power rights to New York State for

(Continued on page 39)

WATER-POWER PROJECTS PLANNED AND UNDER CONSTRUCTION



Location of projects on which the Federal Government has started work or has made appropriations, such as Boulder Dam, Bonneville, Grand Coulee, Fort Peck, Casper Alcove, Verde, Dam No. 3 and Cove Creek mentioned in the article. Projects are also shown to which attention is being given by private or governmental agencies. These include the Missouri Diversion, the Tri-County Irrigation & Power, Aurora-Landing Dam and the Chickamauga Dam projects.

ELECTRICITY

Waterwheel generators of record size; improved motors; variable-speed A.C. motor using electronic tubes; improved methods of mercury-arc rectifier D.C. voltage control, and a 300-kw. electronic-tube frequency changer are 1933 milestones

● PROBABLY the most important event in the electrical industry during 1933 was the sharp upward trend in power generation and demands for electrical equipment. In May, the power-generation curve for 1933 crossed that of 1932 and continued rising sharply, until by the end of June it crossed that of 1931. Since then the output of public utility plants has been comparable with that for the last half of 1931. The total generation in these plants last year was about 85 billion kw.-hr., as compared to 83 billion in 1932.

Although there was a sharp increase in demand for electrical power equipment during the last twelve months, it has been mostly for apparatus of standard designs. Boulder Dam generators, which are rated at 82,500 kva. at unity power factor, are an exception. Contracts for four of these machines were divided between the General Electric and Westinghouse companies. A fifth unit of 40,000 kva. rating is being built by Allis-Chalmers, which also has a contract for the four large waterwheels. The large generators are designed to supply 50-cycle, 13,800-volt current when running at 150 r.p.m., and 60-cycle, 16,500-volt power at 180 r.p.m.

Because of problems encountered in transmission of the power 265 mi. to Los Angeles, special features will be incorporated in these generators to make them equivalent to machines of 125,000-kva. rating and normal characteristics. Two of these generators will normally operate in parallel and will connect to a bank of three single-phase, 55,000-kva. transformers. The power will be transmitted to Los Angeles over a two-circuit transmission line operating at 275,000 volts at the receiving end and from 280,000 to 330,000 volts at the sending end.

Work was done on only three major steam-plant projects during the last year. A 183,333-kva. turbine generator is being built for the Richmond station of Philadelphia Electric Company. Buzzards Point plant of Potomac Electric Power Co. had one 35,000-kw. unit put into operation. A third development, Port Washington plant of Milwaukee Electric Power and Railway Company, has an initial installation of one 80,000-kw. unit.

No increase in generator voltage was made during the last year, the 22,000-volt machines at State Line station being the highest in this country. Last year's report mentioned the 33,000-volt generators being built in Europe. Since that time another machine for that voltage has been ordered so that now there are in operation or under construction eight units, aggregating 200,000-kw. capacity, for operation at 33,000 to 36,000 volts.

Development of geared motors and motorized speed reducers (combining a high-speed motor and a reduction gear) continued during the last year, and several new designs were reported. An interesting development is a gearmotor for an adjustable-speed drive. It is rated at 20, 40 and 40 hp. with a rotor speed of 700, 1,600 and 2,400 r.p.m., and output-shaft speeds of 83, 178 and 267 r.p.m. The control is mounted in an enclosing case on the motor so that the whole equipment may be handled as a unit, and simply by connecting the line wires it is ready to run.

Synchronous motors, because of their superior power-factor characteristics, high efficiency, adaptation to almost any speed and other favorable features, continue to attract attention, and their field of application is being extended by new designs. One electric manufacturer reports development of a synchronous motor for drives requiring very high starting torque that can be applied in increments, such as needed for flour-mill lineshafts and cement-plant tube mills.

Another important development was a totally enclosed fan-cooled synchronous motor of novel construction, Fig. 1. This motor was designed primarily for operation in corrosive atmospheres, or where the air is laden with salty or caustic moisture. Two of these motors, each rated at 300 hp. at 360 r.p.m., are operating outdoors. The largest supersynchronous motor, both in physical dimensions and torque rating, 800 hp., was applied last year to driving a large flour-mill lineshaft.

A new variable-speed, alternating-current motor utilizing Thyraton tubes was built and tested. It is rated at 400 hp., 4,500 volts, 3-phase, 60 cycles and is designed to give a speed range with series characteristics from zero to 925 r.p.m. Its construction is similar to that of a synchronous motor, the stator having three windings, each of which carries current in succession. But the rotating field is series wound and carries the full stator current.

Considerable work has been done in design of totally enclosed, fan-cooled, wound-rotor and squirrel-cage motors. Wound-rotor motors of this type were built in sizes up to 200 hp., at speeds as high as 1,800 r.p.m.

Base-ventilated induction motors have been developed for ratings of 200 to 1,500 hp. The motors are for operation in gaseous and dirty atmospheres. Ventilating air is taken from a clean outside source and enters the housing directly below each bearing. This air passes up around the bearings and stator windings, then goes around the stator to discharge openings in the central portion of the base.

Mountings to isolate motors from their foundations, give quiet operation and absorb shock are being given considerable attention. These mountings are required on motors in public buildings and certain industrial applications. Flexible mountings have been developed for induction motors up to 50-hp. rating.

Improvements made in many classes of equipment during the last ten to fifteen years offer economic possibilities for remodeling older designs or replacing them entirely by new apparatus. Transformers come into this category. As an example, during the last year a group of six 5,250-kva. high-voltage transformers were remodeled by providing them with new interiors. This change increased their capacity to 6,250-kva., increased their impulse strength 2.5 times and reduced their losses until they are less for the modernized units than for the old ones. In another instance, a group of 750-kva. transformers was provided with new core-and-coil units that reduced their core losses 49.3 per cent, load losses 26.2 per cent.

A new insulating and cooling medium, known as Pyranol, that is non-flammable has been developed as a substitute for insulating oil in transformers and other electrical equipment. New designs of network transformers filled with Pyranol have resulted in a material reduction in external dimensions. Two 500-kva., 3-phase transformers, one of standard oil-filled design and the other a new-design, Pyranol filled, had a height for the latter of only 60 in. compared to the 88.5 in. for the former, with widths of 98 in. and 106.5 in. respectively. For network installations, it is reported that costs of Pyranol-filled transformers are comparable with those of oil-filled units because of savings that can be made in vault constructions.

Protection has been developed for distribution transformers that will handle the enormous currents from direct lightning strokes without interrupting service. Overloads and secondary short-circuit currents are cleared by a small circuit breaker built into the transformer, the tripping element of which responds to both oil temperature and load current.

Mercury-arc rectifiers continue to gain for direct-current supply from alternating-current systems. One of the large installations reported for the year comprises nine 3,000-kw. sectionalized units in automatic underground substations on the new New York subway.

Regulation and control of direct-current output voltage of mercury-arc rectifiers by energized grids is an accomplished fact. A twelve-anode rectifier of this type, rated at 5,000 amp. nominal 625 volts, has been in operation for several months. In it, grid-control equipment is arranged so that direct-current voltage can be maintained within desired limits at all loads without tap-changing equipment and without interrupting the flow of power.

There have been a great many improvements in electronic tubes, and their field of application has been extended. An outstanding development is the first Thyratron frequency changer built for commercial service, which has a capacity of 300 kw. It transforms 3-phase, 60-cycle, 2,300-volt power to 2-phase, 25 5/7 cycle, 220-volt power to supply a motor load.

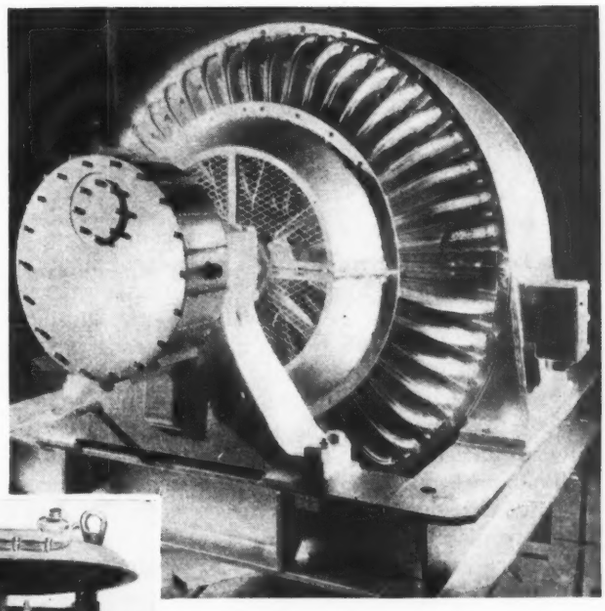


Fig. 1—Totally enclosed, fan-cooled 300-hp., 360-r.p.m. synchronous motor for operation in corrosive atmospheres

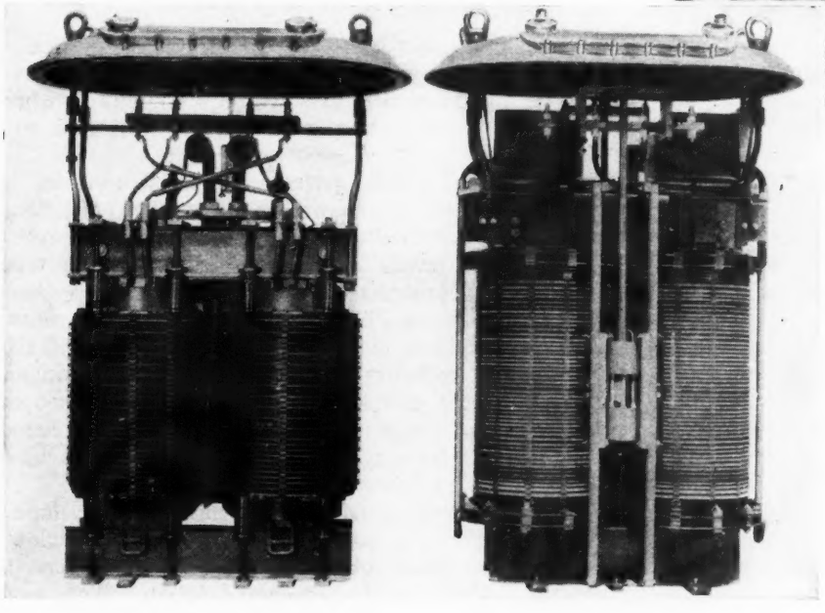


Fig. 2—On the left, original core and coils in 1916 design of 5,250-kva. transformer. On the right is the remodeled core and coils, which have a rating of 6,250 kva., but go into the original tank

METERS AND CONTROL

New methods of measuring large volumes of water; extended range of oscillograph applications; meters that measure and analyze noise; improved automatic combustion control, and centralized control for diesel-engine generating plants are developments in metering and control

● METERS and control equipment continue to be in the field in which the greatest number of improvements are reported. Not only have many new devices been developed during the last twelve months, but older and more-or-less standard equipment has been improved extensively. One of the dominant demands is for greater accuracy and flexibility. During the year just past, standard metering methods have been carefully scrutinized for possible errors and means devised to eliminate them. New ways of applying old methods to insure a high degree of accuracy have also had a prominent place in the program.

Nowhere has the latter been more apparent than in the field of measuring large quantities of water to hydro-electric plants. Many of these plants are now operated with as complete records as are maintained in the best steam plants. Furthermore, a high degree of accuracy when testing hydro units has become very important. Where penstocks are of sufficient length, the Gibson time-pressure and the Allen salt-velocity methods are highly accurate, but intakes to many low-head plants prohibit their use or at least cast doubt on accuracy of results. It is in this field that much attention to water measurement is now centered.

When testing the 42,500-hp. Safe Harbor units was decided upon, because of their short penstocks, current meters were one of the methods selected. The large size of these units, large volumes of water involved and the limited experience with current meters in this country made the work a pioneer undertaking. After extensive research, a two-current-meter method was developed. In this system, two types of current meters are used having opposite characteristics in running water, one type being retarded by oblique flow and the other accelerated by approximately an equal amount. Thus, true discharge can be obtained by averaging their readings. These meters are mounted in two rows, one type in each row on a frame as in Fig. 2, and arranged so that a traverse can be made of all three intakes simultaneously, during which time the frame is moved vertically at constant velocity.

A new method of applying pitot-tubes to the measurement of water has been developed. This method, known as Photoflow, is a photographic record of the differences in pressures of pitot-tube points positioned throughout the cross-section of flow and of piezometers placed to indicate pressure across the section. An accuracy within one-half of one per cent is claimed for this method.

Outside the field of water measurements, there have also been many advances in metering methods. For several years, considerable attention has been given to making oscillographs more easily applied to general testing of electrical equipment and circuits. This work is being continued, and last year several improvements were reported, among them a new portable multi-purpose equipment. Of a construction comparable to the average electrical indicating instrument, it may be used by those who are not experienced oscillograph operators to make comparative measurements of amplitude, phase, frequency or wave shape.

A new continuous-drive record-paper holder has been developed for use with a six-element general-purpose oscillograph, designed to use sensitized paper in rolls 100 ft. long, and 6 in. wide. The entire length of paper may be used for one continuous record, or a number of shorter records may be obtained on one roll by starting and stopping the paper. The use of automatic oscillographs has been extended by development of an over-voltage relay designed to start the oscillograph when the voltage rises above a predetermined value in any phase.

To assist in attacking the noise problem, which is assuming increasing importance in power applications in many classes of buildings, noise meters are now available. One consists of a high-quality vacuum-tube amplifier which amplifies the voltages generated by sensitive microphones. A calibrated meter, which measures the amplifier output, gives the intensity of the sound wave impinging on the microphone diaphragm. If the sound is complex, an analyzer may be used to determine the frequencies of the various components and their relative magnitude. An analysis of machine noise often gives clues as to the offending parts.

Several systems of telemetering have been developed by which records of volts, amperes, power, liquid flow, pressure and other quantities may be reproduced a long distance from their point of origin. Two new

systems, the Pilotel and the Chronoflo, were announced last year. The former uses the grid circuit of an electronic amplifier to transmit rate or quantity records, while with the latter this is done by electrical impulses produced mechanically.

The use of mercury boilers has developed the need for a device that will detect very small mercury vapor leaks. Sensitive devices have been available for doing this, but last year a new one was announced that is three times as sensitive. It will detect one part of mercury vapor in 100 million parts of air. This new detector is another device that photoelectric tubes have made possible.

In the field of standard power-plant meters, there have been many refinements in design, and the use of instruments is increasing in power plant and in industrial applications. It is becoming more generally appreciated that the power plant and services supplied by it offer opportunities for savings that may mean profits when otherwise a business would be operated at a loss. Most new industrial power plants are installed because engineering studies indicate they will make a saving that will return their investment over a period of years. To do this, the plants must be intelligently operated, which means that meters must be provided and records kept that will allow operating under practically test conditions. This applies also when these services are purchased from a utility company.

In the control field, automatic combustion control of boiler plants still holds a leading place. A new air-operated system was announced last year. The feature of this system is a free-floating air pilot valve that fulfills exacting control requirements without affecting the accuracy or range of indicating or recording instruments to which it may be connected. The pilot valve is very sensitive; only 0.004 in. of movement of the valve is required to obtain complete control drive travel. Other companies report redesigning their lines of automatic combustion control equipment.

Engineers have generally considered that the greatest benefit is obtained from automatic combustion control when boilers operate under variable load, but it is also now being installed on base-load boilers. Benefits resulting from a reduction in operating supervision and the increased facility with which the boiler may be handled justify the installation.

In large modern boilers, even if combustion control is manual, it should be by pushbuttons from a central location, combined with interlocks to insure that the various pieces of equipment will be operated in proper sequence. If the cost of pushbutton control and safety devices is credited to that for full-automatic control, only a small increase in annual boiler efficiency is necessary to make profitable the additional investment for the latter.

An outstanding achievement in plant control is that used with the five 7,500-kva. diesel-engine generating units at Vernon plant in California. Control for each unit is located on an individual control board, Fig. 1, installed directly behind each engine. Here are mounted pushbuttons for starting the auxiliaries for that particular engine. By using magnetic control for all auxiliaries, it is possible to arrange the pushbuttons so that the operator, when starting the unit, presses successive start buttons in a logical sequence. By the time the last button is pushed, pumps and blowers have come up to speed and the whole unit is ready to go on the line, the operation from a cold start taking less than two minutes. Automatic load and frequency control is also provided.

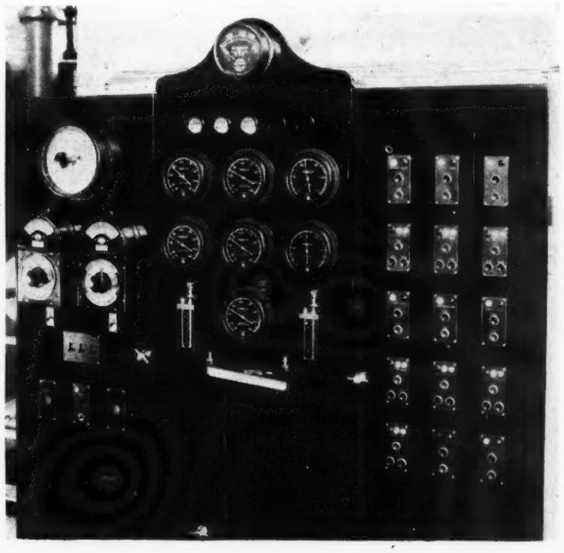


Fig. 1—Control board for one of the five 7,500-kva. diesel engine generating units in Vernon plant.

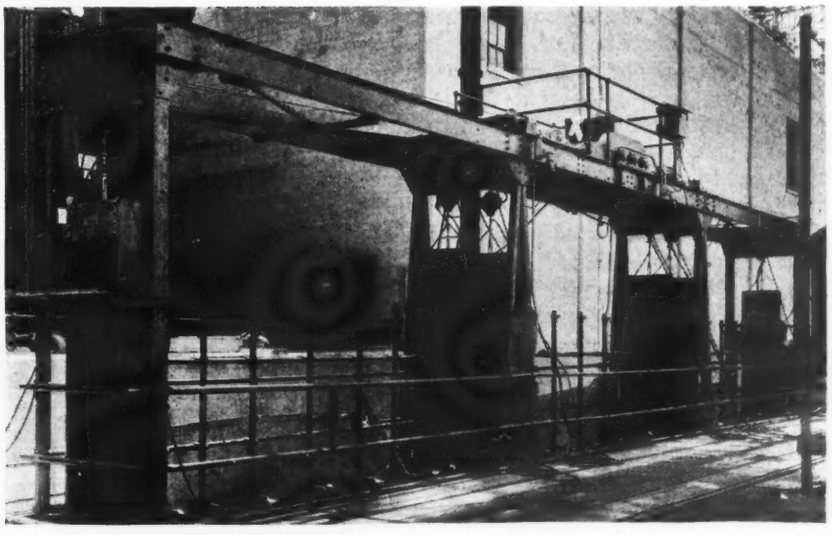


Fig. 2—Current-meter hoist frame set over emergency gate slots in three intakes to one of the 42,500-hp. units at Safe Harbor plant preparatory to making a water-measurement test.

AIR CONDITIONING AND REFRIGERATION

Interest in air conditioning increased during the year, due largely to business' recognition that it is a definite sales aid. Steam-jet vacuum refrigeration has become more popular, unit heater-cooler combinations are being introduced, and combination gas-engine compressors are brought out

● INTEREST in air conditioning has continued throughout the year despite present economic conditions, due probably to a greater recognition of the advantage to business that comes from its use. Thus, restaurants, department stores and offices have installed air conditioning to attract trade or improve rental of office space.

Notable during the past year has been the acceptance of steam-jet vacuum refrigeration for air conditioning and a greater appreciation of the adaptability of unit air conditioners to small spaces and in modernizing old buildings.

Nowhere near as many new air-conditioning units were brought out last year as during the preceding year. Engineers and manufacturers will view this with satisfaction, as there are undoubtedly too many units on the market at the present time.

A diagram of one of the units brought out during the year is shown in Fig. 2. This unit is designed for use in rooms of about 5,000 cu.ft. and contains its own refrigeration system capable of lowering the room temperature 10 to 15 deg. A feature of the unit is its ability to change from a cooling to a heating unit by operation on the reversed refrigeration cycle. Likewise, the condensation collected from the air-cooling coils is used in the condenser section of the refrigerating unit to aid in condensing the refrigerant. The unit operates entirely by electricity, requiring 2 kw.

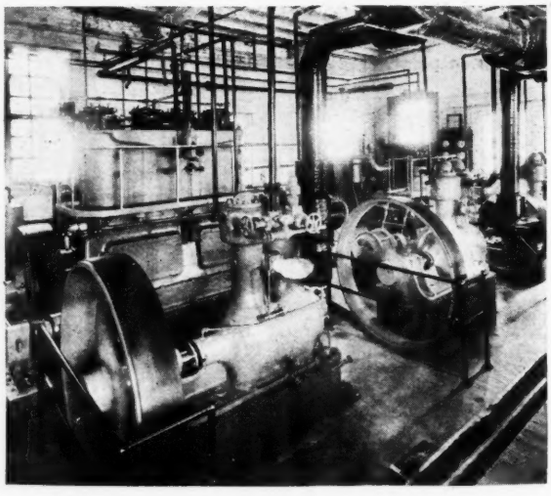
Several department stores in the South have successfully used unit heaters for room cooling during the summer by circulating through them brine or a special fluid cooled in a central refrigerating plant. This type of cooling has the advantage of low first cost and can be installed with minimum disturbance in the store.

During last year the two largest steam-jet vacuum refrigerating units were placed in operation in Radio City. Each has a capacity of 300 tons and furnishes refrigeration for air conditioning for the entire British Empire and French buildings. The distribution of conditioned air in these buildings also embodies a new principle. Air is discharged vertically from registers under each window and at sufficient velocity to entrain room air with it due to the ejector action. A damper provides manual regulation of the amount of air delivered. Return air is taken through one register in the elevator lobby of each floor. Fin-type radiators are provided at each window behind the air ducts, but it would seem that the next logical step would be their elimination, making the air-conditioning system serve for heating in winter as well as cooling in summer.

Considerable attention is being given to the problem of corrosion in central plant air-conditioning systems. This corrosion occurs mostly in the air washers and may be largely overcome by maintaining a proper pH value of the cooling water. Soda ash, caustic soda and special compounds are used for this purpose.

An outstanding development of the past year is the perfection of a centrifugal vapor compressor which uses water as a refrigerant. The unit is available in sizes of 50 to 300 tons and operates much like the steam-jet vacuum refrigeration system except that the centrifugal compressor takes the place of the steam jet. The compressor operates at 7,000 to 10,000 r.p.m., driven either by motor or steam turbine. This refrigerating unit differs fundamentally from all other types in its part-load characteristics. In general, the unit operates at constant speed. Under this condition

Fig 1—Two ammonia compressors are driven from opposite ends of a 165-hp. gas engine at the plant of Heights Ice Co., Houston, Tex.



and without any other adjustments, reduced loads are automatically reflected in reduced power input approximately in proportion to the decrease in tonnage. Because its cooling water requirements are lower than that of the steam-jet vacuum system, this unit may be found advantageous where cooling water costs are high.

A refinement for the refrigerating plant is an air purger which frees the condenser of air automatically. The purger operates regardless of the condenser pressure.

The new refrigerant, Freon, received increased acceptance during the year, particularly for air-conditioning units. It is being used in direct-expansion surfaces, eliminating the necessity of cooling water or brine.

Fig. 2 — Air-conditioning unit arranged for reversed refrigeration

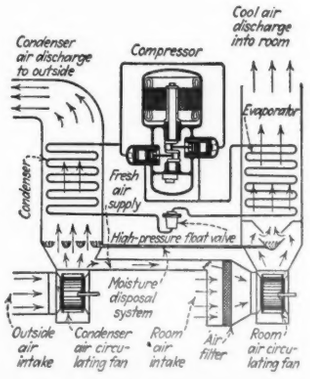
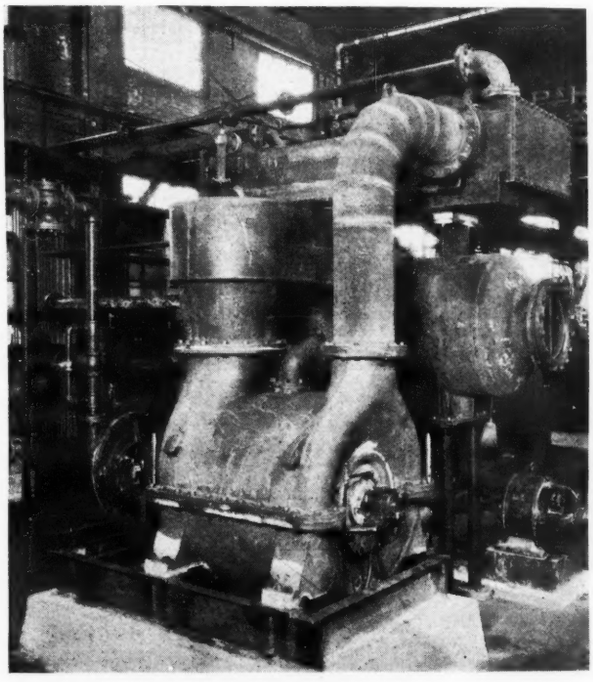


Fig. 3 (Below)— Experimental water-vapor centrifugal refrigerating unit



Freon has a great affinity for oil and is an excellent cleanser, hence the system in which it is used must be thoroughly cleaned before being charged with the refrigerant.

No major developments have been made on reciprocating compressors. More compressors are being driven by diesel and gas engines. One manufacturer has brought out a complete line of gas-engine compressors. The compressor cylinder is mounted on the engine frame and its piston is driven by the same crankshaft. This arrangement has also been used on diesel engines.

WATER POWER

(Continued from Page 33)

$89,000,000 to pay the United States' share of the power-project cost. President Roosevelt has expressed himself in favor of this resolution and ratification by the Senate of the Great Lakes-St. Lawrence deep waterway treaty with Canada. There is strong opposition developing that may prevent ratification of the treaty by this Congress, or at least delay this until late in the year.

Few new developments can be reported other than those mentioned a year ago. Work on a pump-turbine runner has been continued, details of which are given in the article on pumped-storage plants, Page 20. Reports indicate an increased use of stainless steel in waterwheel repair. Areas that are subjected to pitting as a result of cavitation are being repaired by welding with stainless steel, with good results. This material has been used quite extensively in Europe for waterwheel construction, particularly for blades of propeller-type runners. It is reported that a runner is now being built in this country of this material.

Considerable attention is being given to governor improvements. Governors are now available that will respond to speed changes of less than 0.01 of one per cent and will divide load property between units operating in parallel on an inherent speed drop of less than half of one per cent. These improvements have greatly facilitated maintenance of close frequency control for accurate system time.

In Canada, work has continued on several large projects. In Quebec, the MacLaren-Quebec Power Company put into operation its 136,000-hp. plant on the Leivre River, near Ottawa. The Beauharnois Light, Heat & Power Company awarded contracts to Dominion Engineering Works for the necessary parts to complete six 53,000-hp. turbines for the Beauharnois plant. Delivery of the first unit is to be March of this year. When these six units are installed there will be ten main units and two 8,000-hp. service units, a total capacity of 546,000 hp. The project is designed for 42 main units, each of 53,000 hp. In Ontario, the two initial 66,000-hp. units have been put into operation in the Abitibi Canyon plant of the Hydro-Electric Power Commission of Ontario. This plant is laid out for five units, or 330,000-hp. total capacity.

Shawinigan Water & Power Co. has resumed work on its Rapide Blanc project near La Tuque, Que., on the St. Maurice River. Owing to a greatly increased demand for power, it is planned to have an initial installation of 80,000 hp. ready for operation by May 1. This plant is designed for 240,000 hp. in 6 units of 40,000 hp. each and is part of a plan to develop the 1,200,000 hp. in six plants on the upper St. Maurice.

A 4,600-hp. hydro plant is to be built by British Columbia Electric Railway Co. on the site of the Seton Lake project, to supply the Bridge River gold-mining region. A 600,000-hp. project is planned for this site and a 2.5-mi. tunnel has been completed with a capacity of 216,000 hp., but because of business conditions the project has been temporarily suspended. Water will be pumped under a low head into the intake end of the tunnel and used under about 1,200-ft. head at Seton Lake in a 4,600-hp. plant. The tunnel will also serve as the storage reservoir for the plant.

PUMPS IN 1933

Waterworks-pump motors with unusually high efficiency; propeller pump with adjustable blades; centrifugal pumps for 7,500-ft. head in a single casing; pipe-line pumps with motors cooled by liquid being pumped—these are high spots for 1933

● PUMP DEVELOPMENTS last year were, for the most part, along lines previously established. Work got well under way on the new water system for the Metropolitan Water District of Southern California to bring water 250 mi. from the Colorado River to Los Angeles. This project includes five pumping plants with sufficient pump capacity to deliver one billion gallons per day against a head of over 1,600 ft. Contracts for pumps for this project have not been let.

In the waterworks field, the six single-stage pumps under construction for the Cermak station in Chicago are among the most outstanding. These pumps are each rated at 50 m.g.d. against a 136-ft. head and will be driven by 1,500-hp. synchronous motors at 514 r.p.m. These motors are of particular interest. They are designed to be started by connecting directly to the line and will take a current inrush of less than 400 per cent full-load value. Second, because operation will be practically continuous, the over-all combined efficiency of the motors and their exciters has been made nearly 98 per cent, comparable to normal efficiency of a 25,000-hp. motor.

A 30-m.g.d., 250-ft. head booster pump driven by a 1,500-hp. synchronous motor, Fig. 2, was installed by the City of Milwaukee. This unit will be used to pump into an elevated tank during off-peak periods and is an example of how motor-driven pumps may be used economically to supplement steam-driven pumping plants.

The two, vertical, mixed-flow pumps being installed on the water system of Washington, D. C., are of interest. There are four of these pumps, three having a capacity of 108 m.g.d. each and one 25 m.g.d. to operate under a static head of 7 ft. These pumps are installed in a forebay built around the end of the conduit coming into a receiving reservoir and will discharge into the main reservoir. By lowering the water level in the forebay 7 ft., the flow in the conduit will be increased 17 m.g.d. These pumps will be driven by synchronous motors mounted directly on the pumps.

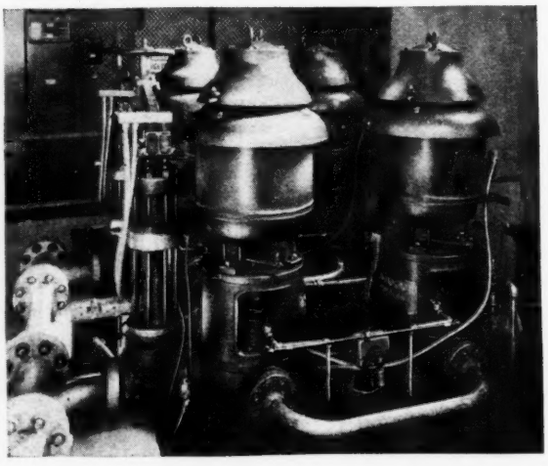
Because of practically a cessation in large steam-plant construction there has been little activity in building large boiler-feed and circulating-water pumps. One manufacturing company reports installing two 55,000-g.p.m. circulating pumps in 1933 and has a 75,000-g.p.m. unit under construction. All three of these are of the propeller or screw type. There appears to be a preference for this type of pump for single-pass condensers.

Adjusting the runner blades of propeller pumps improves their characteristics just as it does those of propeller-type turbines. Discharge of the pump may be held constant while the head is varied over a wide range, or the output may be varied under a constant head, either with a good efficiency. Development work has been completed on a pump of this design, performance data obtained from an 11-in. model runner is given, page 242, May, 1933, *Power*.

A great deal of attention is being given to centrifugal pumps for high heads. In the fall of 1932, two pumping units, Fig. 1, were installed to pump water out of the Grand Canyon. These comprise two 90-g.p.m., 17-stage pumps in series to operate against a 3,500-ft. head. When installed, the pumps developed an efficiency of 65 per cent. They were tested again after one year's service and showed no apparent change in efficiency.

This year, the work of developing high-head pumps has been carried further, and units have been built of similar capacity for 2,400-ft. head in a single casing. For a capacity of 150 g.p.m., units have been built for 3,300 ft. head in a single casing, operating under 6,600-ft. head with two pumps in series for oil-refinery service. This type of pump has also been developed for capacities as low as 10 to 20 g.p.m. on heads of

Fig. 1—Each pair of pumps operates in series and discharges 90 g.p.m. against a 3,500-ft. head



800 to 1,000 ft. Hot-oil charging pumps were developed for capacities up to 1,000 g.p.m. and heads as high as 7,500 ft. in a single casing.

Another line of high-pressure centrifugal pumps has been developed for heads up to 2,300 ft. These pumps are primarily for pipe-line service handling crude oil and gasoline. They have four to six stages, operate at 3,500 r.p.m. and are driven by electric motors. These pumps have opposed impellers to give hydraulic balance and have stuffing-box inclosures with glass windows. These permit observing leaks from stuffing boxes without allowing vapors from lighter distillates, such as gasoline, from leaving the pump.

On a new line of refinery pumps, stuffing-box leaks have been eliminated by using extra deep water jackets arranged with pressure break-down and bleed-off connections; split-steel smothering glands which smother with a stream of water any leakage that might get past the stuffing-box packing, these glands being bronze bushed to prevent sparks; and stages arranged so that pressure on any stuffing box is never more than that in one stage above suction pressure.

One of the most unusual developments in pipe-line centrifugal pumps is the Rannett type reported last year. This pump is motor driven and is designed for outdoor operation. One of these pumps was installed in 1932 on the Great Lakes Pipe Line Co.'s gasoline pipe line at Paradise, Mo. The 700-hp. driving motor is totally enclosed with a double-walled stator frame through which the gasoline going to the pump circulates to cool the motor. This pump has eight stages and is designed for 1,000 g.p.m. against a 2,500-ft. head of gasoline. This year, 14 more of these pumps were sold for use as booster service to the same company.

Reciprocating-type pumps are still being sold for pipe-line service. One of these pumps is shown in Fig. 3 and is a 36-in. stroke, triplex, plunger type. A feature of this pump is the enclosing of all the valve box covers with sheet-steel and aluminum hoods. The oil piping and the guard rails at the outer-end movement of the crosshead are chromium plated. This indicates a trend toward better appearance, something given very little attention for this class of pump a few years ago.

Increasing use is being made of pumps in the smaller sizes for a speed of 3,600 r.p.m. The reason for this is that a centrifugal pump's capacity increases as the speed and the head increases as the square of the speed, which means the higher the speed the lower the cost of the pump for a given capacity. One company reports a line of 3,600-r.p.m. pumps for nearly all heads above 200 ft. in multi-stage types; 100 ft. for capacities down to 50 g.p.m. and 20 to 100 ft. for capacities less than 50 g.p.m. with single-stage designs.

Last year also saw considerable development in small sizes of motor pumps. This design is a unit in which the pump is mounted directly on the motor, there being no bedplate or flexible coupling. The introduction of motorized pumps for the smaller capacities has served to reduce materially the cost of pumping equipment and has resulted in a more compact unit. These designs are giving satisfaction and follow the trend in design of other equipment where the motor is built into the machine it is driving or into the mechanical transmission, to obtain compactness, increased efficiency, lower weight and cost.

New lines of single-stage and multi-stage split-case centrifugal pumps have been developed. One of these is a complete family of homogeneous pumping equipment with a head coverage up to 300 ft. and for capacities up to 3,000 g.p.m., with efficiencies ranging from 78 to 87 per cent depending upon capacity-head requirements.

Various devices have been used to balance the thrust in centrifugal pumps and study is still being given to the problem. Last year, one pump manufacturer announced a means to correct for all unbalanced forces in its pumps by a proper proportioning of the shaft-covering diameter between opposed impellers. These pumps are also equipped with a thrust bearing to take care of any unusual conditions, such as foreign matter lodging in the pump.

Developments to make centrifugal pumps self-priming continue to be one of the most active in the pump industry. Several new designs were announced last year.

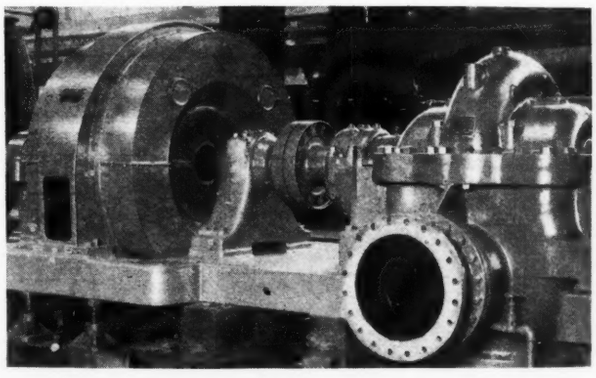


Fig. 2 — A 30-g.p.d., 250-ft. head pump driven by a 1,500-hp. synchronous motor

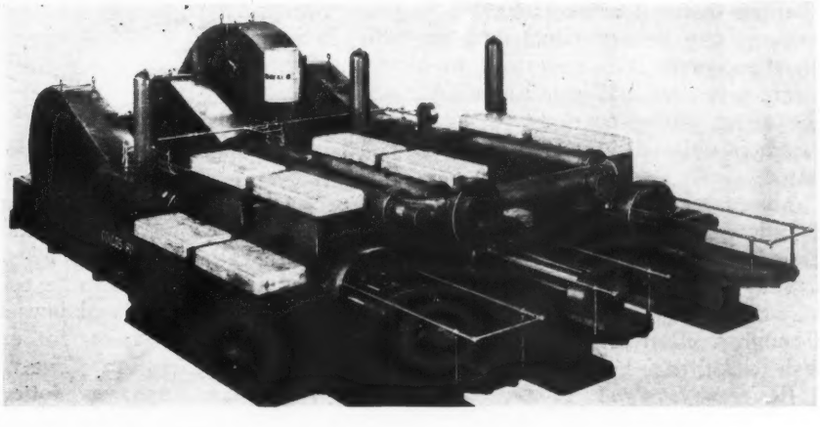
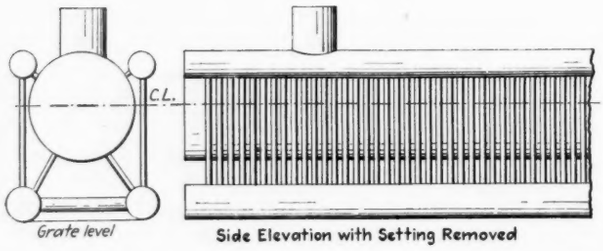


Fig. 3—A 36-in. stroke, triplex plunger pump with its valve boxes covered with sheet-steel and aluminum hoods

PRACTICAL AIDS TO OPERATION



Side Elevation with Setting Removed

A Boiler Water Wall Of Ancient Vintage

WATER walls now used in boiler settings remind me of one on a boiler that I operated at a silver mill in Nevada. The diagram, drawn from memory, gives an idea of it. How old the boiler was I do not know, but Rossiter W. Raymond, in a geological report published in 1877, mentions it. Since the boiler was too small for the mill, its heating surface was increased by adding two water and two steam drums connected with tubes. The steam drums were 10-in. pipes with caps screwed to each end, the water drums were 14-in. pipe with cast flanges at the front and a cast cross tube at the rear equipped with blowoff pipe. Another blowoff was connected with the bottom of the back head of the boiler. The tubes were 2½ in. in diameter, spaced 5 in. center to center. They were expanded at each end, which must have required a special tool. A 2½-in. pipe connected each water drum to the front head and a 2-in. pipe connected each steam tube to the shell.

Sage brush and, later, coal was used for fuel. How effective the water walls were is shown by the fact that ordinary brick was used for the setting, except for lining the front, and the bridge wall. The boiler was a horizontal return tubular, 42 in. in diameter by 16 ft. with 38 4-in. tubes. When I took charge (after the mill had been shut down for twenty years) the safety valve was set for 90 lb. blowoff. I cleaned the boiler, tested it to 150 lb. water pressure and operated it for several years.

St. Louis, Mo. L. R. BAKER

Care of Mercury in Steam Flowmeters

WHERE steam flowmeters have a mercury column, the mercury may be contaminated by impurities in the steam. In these cases it is necessary to blow the connecting steam pipes out and install a suitable steam filter where the meter piping connects to the steam main. If the steam is quite clean, the mercury will not be contaminated.

Mercury can be cleaned sufficiently for use in meters by allowing it to fall in a fine spray into a solution of 25 parts nitric acid and 75 parts distilled water. The mercury should then be collected and passed in a similar way through distilled water. It may be dried by passing through a clean filter and then heating in a porcelain dish to 230 deg. F. for a short time.

Welwyn, England W. E. WARNER

Abrasive Dust Wears Pulley Crowns

IN LOCATIONS where there is much abrasive dust in the air, wearing off of pulley crowns may occur. Two expedients may be applied to minimize the damage, besides screening the belt and pulley from the dust as much as possible.

Where horizontally running belts are used, it is considered best practice to operate them with slack side on top, because this arrangement increases arc of contact on the pulleys. When running in abrasive dust, if the slack side of the belt is on the bottom, there will be a flapping of the belt that will help to keep the abrasive off its surface.

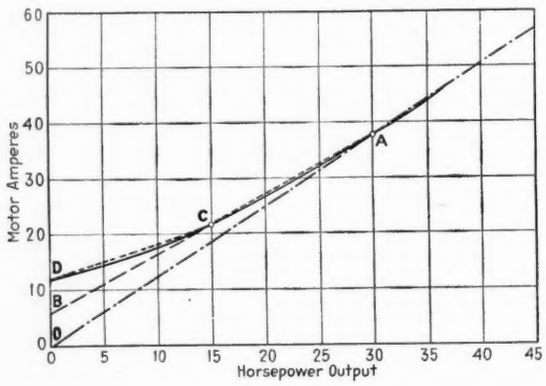
Directing a strong current of air on the belt where it is about to come into contact with the under side of the pulley will also help to keep it clean. A type of belting is available that has its inner surface grooved to produce a blowing action as it makes contact with the pulley. This will also be effective.

Peoria, Ill. JOHN E. HYLER

Induction-Motor Output Determined With an Ammeter

WHEN load tests are made on motors, a watt-meter is generally used to obtain power input in order to calculate power output. Even when power input is known, it is necessary to assume a motor efficiency to calculate horsepower output. Since factory test data covering the performance of a motor under test are seldom available, an efficiency must be assumed. This immediately introduces a possible source of error, depending on the observer's guess.

A simpler method has been developed that requires the tester to measure the motor current only. It may be



applied to either alternating- or direct-current machines. The only instrument required is a Tong-Test ammeter that can be connected to the circuit by closing trigger-operated jaws around one of the line wires.

Take, for example, a typical squirrel-cage induction motor. The full-line curve in the figure is actual line amperes plotted against horse-power input for a 30-hp.,

440-volt, 3-phase, 60-cycle, 900-r.p.m. motor. The dotted curve was approximated by means of the ammeter method. It will be seen that the error by the simpler mehod is so small that it may be practically disregarded. The dotted test curve is plotted as follows:

Point *A* is full-load amperes given on the motor nameplate. Point *D* is obtained by measuring the motor's no-load current with the ammeter. Draw dash-and-dot line *OA* through zero and full-load point *A*, extending it to take care of overload if required. Next draw the line *BA*, with *OB* made one-half *OD*. Then draw *DC*, point *C* being the intersection of line *BA* and the 50 per cent horsepower output ordinate. Thus there has been constructed an approximate curve *DCA* of line amperes and horsepower output. From this curve the horsepower output corresponding to current input for any load may be readily determined.

In the specific case of this 30-hp. motor, the full-load current rating is 38 amp. and the measured no-load current of the motor is 12 amp. Therefore, *OB* is 6 amp. The curve *DCA* may be constructed, and any horsepower output determined by measuring the line amperes at a particular load. For example, if the ammeter reading is 30 amp., the load is about 22.5 on the constructed curve *DCA*. The actual load at this current, as shown on the factory test-data curve, is about 23 hp., a difference of only about 2 per cent. Even if a wattmeter is use to measure input, and the efficiency were assumed as in the ordinary way it would be difficult to get a higher accuracy than obtained with the ammeter.

Cleveland, O. M. M. Rose
Chief Engineer
Columbia Electric Mfg. Co.

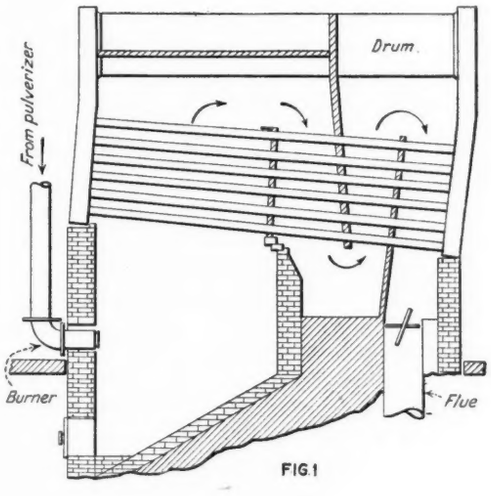


FIG. 1

Changing Position of Burners Corrects Refractory Troubles

The pulverized-coal burners for a boiler plant were originally placed in the front wall of the furnace as in Fig. 1. After the boilers had been in service about a year, it was noticed that the bridge walls showed evidence of severe spalling and erosion, because the flame impinged directly on them. New bridge walls were laid and lasted six months. A gradually increasing load on the boilers called for greater heat release in the furnaces. The boiler and fuel-burning equipment could easily handle the increased load if the refractories could be made to stand up. The difficulty was corrected by constructing miniature Dutch ovens of steel plate bent into the shape of cylinders. These were lined with fire brick. This allowed the burners to be mounted about 3 ft. back from their original positions, as in Fig. 2.

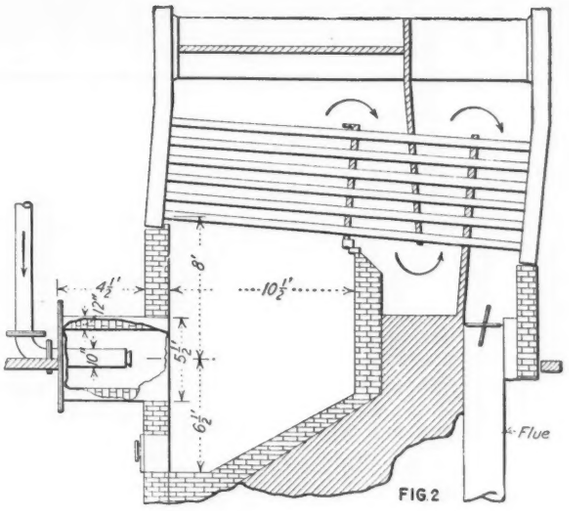
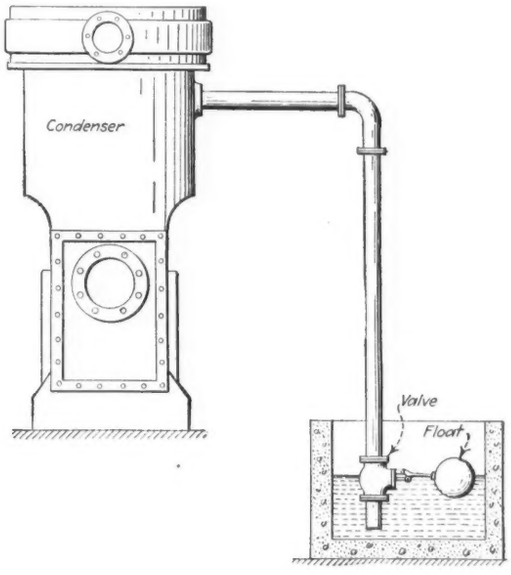


FIG. 2

As a result of this change, an appreciable increase in combustion efficiency was noted, besides, refractory maintenance was reduced to below that considered normal for boilers operating at their ratings.

Milford, N. J. Harry M. Spring.



Uses Condensers as Sump Pump

The diagram illustrates a method I have used to remove sump water with a jet condenser. A ¾-in. pipe, with a float valve installed at its lower end, is connected from the sump to the condenser. When the water rises in the sump, the valve is opened and atmospheric pressure causes the water to flow into the condenser. Before the water level drops to a point at which air will enter the pipe, the float closes the valve. The float is set to keep the lower end of the pipe submerged not less than 3 ft.

In this plant there are four condensers. Sump connections are made so that the connection is always on a condenser in service. This scheme was used while the sump pump was taken out of service for overhauling.

Detroit, Mich. Leonard Long

CURRENT COMMENT

Why Centrifugal Pumps Lose Their Primes

I WISH to add two causes for a centrifugal pump losing its prime to those given in the October *Power*. Vibration or chattering of the impeller will reduce the efficiency of a centrifugal pump. When such a pump is working on a 20-ft. lift, only a slight disturbance will cause a loss of prime. This vibration may be caused by a slight irregularity in the shape of the impeller casting or in the bearing surfaces, or imperfect alignment at the coupling if direct connected. In fact, a direct-driven pump can be affected by vibration in its driving motor, though this condition seldom exists.

A 2,000-g.p.m. pump is heavy enough and has sufficient load strain on its shaft that a slight vibration, especially due to any irregularity of the impeller, would not necessarily be noticeable on the outside of the pump and could be quite disturbing to a pump working on a 20-ft. lift.

Another, though unlikely and unusual, cause of loss of prime is the liberation of gas in the pump's casing or in its suction line due to the existence of gas in the earth from which the water is being drawn. Agitation of the water along with temperature changes assists in liberation of the gas. This cause of losing prime is unusual, but is met with in some localities.

Fort Myers, Fla. F. M. PUMPHREY

Water Column Indications May Be Misleading

I CANNOT AGREE with Mr. Shaffer's suggestion on page 43 of the August number to make the water-level regulator connections to the water-column piping. A water column is installed to show the exact level of water in the boiler, and any passage of water or steam through either of its connections will change the pressure at one end of the column and cause an error in the water level shown by the column. Mr. Shaffer's calculations are correct, and his remedy of putting the regulator three inches lower is right, except that if a heater be installed between the feed and the boiler, the level will be too low. Water at 40 deg. F. is not a desirable feed, not that it is dangerous as some of the older textbooks claim, but it will, in time, cause leaks at the nipple entering the boiler, due to the continued expansion and contraction.

At one time, I was operating a Cook steam head with a vertical boiler, which took steam intermittently. The steam line connected to the boiler at the top head, and the water glass was directly under it. The feed water was very good, but contained some sulphate of soda and a little caustic soda but no scale-making salts. If the boiler was not blown down occasionally, the water would foam in the glass at each upstroke of the pump. When fresh water was used, there would be a slight lift in the glass at each upstroke. I tapped the opposite side and the front over the fire door, and put two more glasses in place. From them, three water levels were indicated while the pump was running.

St. Louis, Mo. F. R. BAKER

More About Blowdown

INTERMITTENT vs. continuous blowdown in the removal of boiler sludge brings up a question that cannot be answered by a generalized reply. This question was brought up by R.P.N. in the September, 1933, number of *Power*.

Many engineers still retain the idea that blowdown is used for the purpose of removing suspended solids (sludge) from the boiler, whereas the sludge scale and suspension-forming material should never enter the boiler. Blowdown actually is for the removal of the salines containing the concentrated salts which remain in solution and their replacement with fresh makeup water of lower concentration. This is necessary to prevent carryover and foam formation.

The presence of sludge or suspensions of any kind in the boiler salines stabilizes foam, thereby increasing carryover. In fact, a few parts per million of sludge reduces the maximum allowable concentration of dissolved solids for the prevention of wet steam several hundred parts per million.

The presence of sludge is also undesirable because in many boilers it may adhere to the tubes or heating surface and bake on as a porous scale.

The primary purpose of a boiler is to produce dry steam and not to serve as a chemical treating, reaction and settling tank. If the scale- and sludge-forming solids are removed, as they should be in a treatment plant before the water enters the boiler, little or no sludge forms in the boiler.

So far as the removal of sludge by blow-off is concerned, the factors to be considered in the individual case are:

1. The type of boiler and location of continuous blowdown connection.
2. The velocity of circulation within the boiler.
3. The amount and character of the sludge.

As to the first, if the continuous blowdown connection is made to the lowest point in the boiler, a somewhat larger proportion of suspended solids may be removed than would be the case if the connection were made to a higher point. But a continuous blowdown connection to a point lower than the bottom of the upper drums is never made due to the danger of tube losses should the blowdown line break or the control valve be tampered with and the boiler drained. The exception is in the case of HRT boilers where the flues are generally spaced so close together that only a bottom connection is possible.

For other than HRT boilers, the question therefore resolves itself into a consideration of the second and third factors given above, namely the circulation velocity and the sludge itself. In most modern water-tube boilers, the circulation rate is high enough to keep most of the sludge in fairly uniform suspension, so that a uniform amount of it is removed by blowoff. Where the amount of sludge is large, it is necessary to blow off more than if the salines were clear, due, first, to the necessity

of removing the sludge as rapidly as it is formed and, second, because sludge so greatly increases foaming tendencies.

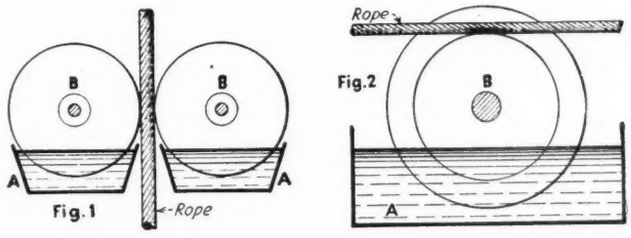
If the sludge is heavy and the circulation rate low, it may be found necessary to supplement the continuous blowdown with an occasional short manual blowdown from the mud drum or mud header. Some operators of continuous blowdown equipment do this as a precaution not only to insure sludge removal but to make sure the manual blowdown valves are free and in good working order should they be needed.

The effectiveness of sludge removal has nothing to do with the manner of blowdown, whether intermittent or continuous, but depends on other factors.

New York, N. Y. T. P. BROWNE
The Permutit Company

Wire-Rope Lubrication

I WAS INTERESTED in the article, "Wire Rope Lubrication," on page 430 of the August number. As the article did not suggest means of applying the lubricant, the devices shown in the diagrams may be helpful. The arrangement in Fig. 1 is for vertical ropes, that in Fig. 2



for horizontal ropes. The sheaves *B* may be mounted so that when the ropes are to be lubricated they are moved in contact with them and are rotated in the oil bath *A*. The sheaves pick up the oil from the bath and deliver it to the ropes. When the ropes are sufficiently lubricated, the sheaves can be moved back out of contact with them.

Another arrangement would be to let the sheaves remain in contact with the ropes and remove the oil bath when the ropes are lubricated. If frequent lubrication is required, the lubricator could be allowed to remain permanently in place and the oil supply replenished each time the ropes are to be lubricated.

What has been said about Fig. 1 also applies to the horizontal rope lubricator, Fig. 2. The sheave can be left in contact with the ropes if continuous lubrication is required, or it may be arranged to be lowered from them, if lubrication is to be applied at intervals. The sheave is made with a deep groove so that the side of the groove will assist in carrying oil up to the top of the ropes. If desired, a brush or a sheet-metal scraper may be arranged between the groove sides above the ropes to scrape off the oil and deliver it to the top of the ropes.

Welwyn, Garden City, England W. E. WARNER

Cold Glue Used as a Belt Cement

I HAVE READ with interest R. L. Baker's comments in the November number on cold glue used as a belt cement. Mr. Baker can prepare a water-proof cement for leather belt joints, as I have done, from ordinary glue and boiled linseed oil. Place the glue in water and heat until it begins to soften, then place it in an iron pot and add one part of boiled linseed oil to about 20 parts of glue. Melt and mix well together. Adding a little borax will prevent putrefaction of the glue. This compound will not affect the tensile strength or the flexibility of the belt. The glue will be permanent, and even if the joint or belt gets wet it will hold. One belt splice that I made with the cement has been in service for ten years and is still in good condition.

Toronto, O. JAMES E. NOBLE

Cleaning Oil-Soaked Floors

THERE ARE at least two points not brought out in the answers to the question, "what is the best and least expensive method of cleaning an oil-soaked basement floor?," in the September, 1933, number of *Power*, that I consider worth mentioning.

I have used fuller's earth in removing oil from cement floors. Due to its quick absorbing power, I find it especially useful in sopping up a puddle of oil that has just been spilled and thus preventing its covering a larger area. A property possessed by fuller's earth that may not be generally known is that it can be reclaimed and used repeatedly. Oil refineries use fuller's earth principally to filter oils and paraffin. It is practically the last thing done to these two products before marketing. Their cost would be considerably increased but for the fact that fuller's earth, when it becomes saturated with free carbon and other foreign materials, is placed in an oven where the inflammable material is burned out of it, making the earth just as good to use over again.

When I was employed as engineer at an oil-cracking still, we had everything from gas oil to heavy fuel and coke spilled on the cement floor of the pump room and the cemented areas under the stills. We always used hot water to clean the floors. Cold or even warm water will not do because the temperature must be as near 212 deg. as it is possible to get it, if good results are to be secured.

Cement basement and ground floors, as a rule, contain considerable moisture, which quite effectively prevents any great penetration of the oil spilled on the surface. The fact that such floors are relatively cold increases the viscosity of the spilled oil and thus retards its ability to enter the pores of the cement. When a stream of boiling water is applied to such an oily surface, the heat lowers the viscosity of the oil, causing it to rise to the top of the water and be carried away. Although this method will cheaply remove the oil and grease, there must be ample drainage to take care of the hot water.

To obtain the hot water we took a 2-in. pipe tee and screwed a 1-in. nipple with a long thread into one end of the run for the steam connection, thus making a simple ejector similar to those used by many engineers to pump out pits. With the cold water connected to the tee outlet, it was only necessary to manipulate the correct valves to secure the desired temperature of the hot water. The steam hose connected to the discharge of the tee had a 1-in. pipe for a nozzle, the end flattened to give a fan-shaped stream. A handle welded to the nozzle helped keep the operator's hands cool.

Rockland, Mass. BURTON W. WHEELER.

READERS' PROBLEMS

Lost Steam

WEIGHT OF STEAM LEAKING THROUGH TRAP?—*In the plant where I work are two 1½-in. steam traps that are passing steam. The steam pressure is 80 lb. and the traps discharge to the sewer. Will you please tell me how to calculate the steam loss through these traps? Would you advise connecting the trap discharge to a feed heater?*—E. S.

There is no way to calculate the amount of steam lost through a leaking trap. In the first place, the fluid passing through the trap is a mixture of water and steam, and the percentage of steam and water is unknown. In the second place, the area of the leak in the trap valve is unknown and can hardly be determined. You can, however, determine the amount of steam leaking through the trap by making the following test.

Place a barrel, say, approximately half full of water on a weigh scale, measure its temperature with a thermometer, and determine the weight of water contained in it. Pipe the discharge from the trap to the barrel of water and allow the trap to discharge into it until the water reaches a temperature of, say, 180 deg. or until the barrel becomes full. Keep track of the time that the trap discharge is flowing into the water barrel. When you stop the trap discharge flow into the barrel, determine the water temperature and weight of water in the barrel. Then from the following equation the weight of steam discharged from the trap can be determined.

$$S = \frac{W_1 (T_3 - T_1) - W_2 (T_3 - T_2)}{H - T_3 + 32}$$

where

W_1 = weight of water at start.
W_2 = weight of water and condensate after trap has discharged into it.
T_1 = temperature of water at start.
T_2 = final temperature of water.
T_3 = temperature corresponding to steam pressure.
H = total heat in steam corresponding to steam pressure.

Having solved this equation for the weight of steam leaking past the trap, it is easy to determine the amount of water discharged through the trap by subtracting from the final weight, W_2, the sum of the original weight of the water in the barrel and the steam discharged by the trap.

For example, let us suppose that the original weight of the water in the barrel, W_1, equals 200 lb. It has a temperature T_1, equal to 70 deg. After the discharge has been allowed to flow into the barrel for 10 min., it is found that the temperature has increased to 180 deg. and the weight of water now in the barrel is 256 lb. The temperature corresponding to 80-lb. gage pressure is 316, and the steam at that pressure has a total heat of 1,184 B.t.u. Substituting these values in the equation, it will be found that the trap discharged 40 lb. of water and 16 lb. of steam during the 10 min., or 96 lb. of steam per hour.

The correct thing to do is to repair the trap and put it in proper operating condition. After the traps are in proper working condition, the water discharged from these traps may be collected in a receiver and then discharged from the receiver to your feed-water heater, assuming, of course, that the equipment so trapped does not contaminate the water and make it unsuitable for the boiler.

What Size Motor?

HORSEPOWER REQUIRED TO DRIVE PUMP—*A 3,000-g.p.m. centrifugal pump is installed on the 385-ft. level of a mine shaft. What size motor is required to operate the pump at 3,000 g.p.m. against a 385-ft. head?*—E.C.P.

The horsepower of the motor for the conditions specified is found by the formula:

$$Hp. = \frac{G.P.M. \times H}{3960 \times E}$$

where H is the head in feet and E the efficiency of the pump. Assuming a pump efficiency of 0.80, the required size of motor is:

$$Hp. = \frac{3{,}000 \times 385}{3960 \times 0.80} = 364$$

The head on the pump, however, is not the vertical distance from the level at which it is located to the point of discharge. What must be determined is the total dynamic head. This is the vertical distance between the source of supply and point of discharge when pumping required capacity plus the friction, entrance and exit losses. The friction and other losses must be calculated in terms of feet head and added to the static head to obtain the head against which the pump operates. These losses are influenced by the shape of the intake, size of the suction and discharge pipes, the number of bends, valves and other fittings in the piping. When the total dynamic head has been determined it may be substituted in the horsepower formula to obtain the power to drive the pump. The efficiency of the pump under operating conditions should be obtained from characteristic curves of the pump supplied by the manufacturers.

Meter Hook-up

SINGLE-PHASE WATTHOUR METERS USED ON THREE-PHASE POWER—*Connected to the leads of a 2,300-volt 3-phase, 60-kw., 19-amp. alternating-current generator are two potential transformers and two current transformers. The potential transformers have a ratio of 2,300 to 115 volts and connect to a voltmeter through a switch so that the voltage can be obtained for each phase. The current transformers have a ratio of 6 to 1 and connect to an ammeter through a switch so that either may be connected to the meter. I want to connect two single-phase watt-hour meters to these transformers. Can this be done and have the meters read accurately? What multiplier would be used with the watt-hour meters to obtain the total load?*—E.J.D.

The watt-hour meters may be connected in the transformer circuits to record the power transmitted. The potential coils of the watt-hour meters are connected to the potential transformers between the transformers and the voltmeter switch. The current coils of the watt-hour meters are connected in series with the current transformers between the transformers and the ammeter switch. One wattmeter is connected to the transformers on one phase, the other to the remaining two transformers. Before making the connections, the current transformers must be short-circuited at their secondary terminals, before opening their connections to connect in the wattmeter current coils. If the transformers are not short-circuited and their connections are opened under load, they will have a dangerously high potential induced in them.

It should be understood that at unity power factor load, both watt-hour meters should rotate in the same direction and at the same rate if the load is balanced. As the power factor decreases, one meter will slow down until at 50 per cent lagging power factor it will stop. For power factors below 50 per cent lagging this meter will reverse.

The transformer multiplier to use with the meter readings is the product of the transformer ratios or $20 \times 6 = 120$.

QUESTIONS for Our Readers

New Oil Burners Under Old Boilers

I AM *contemplating changing from hand firing to oil fuel and have been told that new oil burners under old boilers sometimes result in damage to the boiler or boiler setting. I would appreciate the experiences of other engineers who have made such changes and the precautions necessary to overcome the difficulties*—A. A. B.

Which Depreciates More Rapidly—Diesel or Steam

QUESTION 2

Because of the high efficiency of a diesel engine, it is, in my opinion, less likely to become obsolete than a steam boiler or turbine. Do other readers agree with me in this? That brings up the question of straight depreciation. What is a reasonable life for a diesel engine, based on the actual experiences of POWER *readers?*—F.B.W.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Comparatively Simple Equipment Required for Reclaiming Leather Belts

ANSWERS to November Question 1

THE QUESTION

I should like to know the experience of Power *readers with reclaimed leather belting. How much belting must be used in a plant before it pays to put in reclaiming equipment and what kind of apparatus is required? Where reclaiming is not done in the plant has it been found more economical to send old belts to the manufacturers to be reconditioned or to purchase new belting? What length of service may be expected from reclaimed belting compared with new belting operating under the same conditions?*—M.R.

Operating Conditions Influence Belt-Reclaiming Practice

THE ANSWER to M.R.'s question will depend to a degree upon the amount of belt in use and the conditions under which it operates. When there is a great deal of oil and dirt present or the belts are subjected to abuse, it probably would pay to reclaim them in a plant that used less belting than in a larger plant having better operating conditions.

To remove the grease from a belt, a good grease solvent that is not injurious to the leather must be used. If used with care, gasoline will serve this purpose very well. The belt to be degreased should be rolled loosely and placed in a container of dimensions that will allow the belt to be covered with the degreasing fluid. If gasoline is used, the work should of course be done outdoors to eliminate the fire hazard. About 24 hr. in the gasoline bath should be sufficient. After this has been done, the belt is removed and the gasoline allowed to evaporate.

It will probably be necessary to relap the belt after degreasing. A good set of belt tools should be available, including a lapping machine and a small hand press to press cemented laps together. This is a job for a man who understands the handling of belts.

When the belt has been degreased and relapped, it should be treated with a preservative such as neats-foot oil. This may be done with the belt running under light load on the pulleys, or by immersing it in the preservative for about ½ hr., allowing it to drip, then wiping it dry.

Philadelphia, Pa. C. O. MILLS.

How Belt Reclaiming Is Done in One Plant

FOR A LONG TIME, we have reclaimed or had reclaimed by manufacturers all belts we use. The cost of reclaiming by belt manufacturers is about in proportion to that for new belts, that is, at half the cost of a new belt satisfactory half life can be had from the old one.

Degreasing is simply washing out the oil with some form of naphtha. Varsol is the kind we use. Soak the belt for 24 hr. and dry in the sun if practical for about 12 hr. We roll the belt up in a loose roll and put it in a tub a little larger than the roll and cover it with the degreasing liquid. Wood strips are placed in the bottom of tub to raise the belt about 1 in. to provide space for the oil to settle out. After the belt has been degreased and dried, it should be thoroughly filled with a good animal belt dressing. The belt dressing can be purchased or practically the same thing made by mixing half tallow and half neats-foot oil. Fish oil may be substituted for the neats-foot oil. Melt the tallow to mix it with the oil. Slightly moisten the dry belt with the dressing, using a rag to make the application. The dressing may also be applied while the belt is running on the pulleys, but this should be done without load.

We use belts constructed with waterproof cement and use this cement for all repairs. It is recommended that the cement be purchased from responsible belt manufacturers and used as directed. Several size planes and a new horseshoeing rasp are the most satisfactory tools that we have used for making splices. A satisfactory clamping device for the splices, especially for small belts, is a thin board nailed down over the joint. After the splices have been prepared, take a board 5 or 6 times the length of the splice and a little wider than the belt. Place and nail the belt to the board with one edge of the belt at the edge of the board, and splice midway between its ends. After applying the cement according to directions, put the lap together correctly, press down firmly and as quickly as possible. Then place a board over the splice and put the first nail in the center of the board and splice. Then nail each edge down with a sufficient number of nails to hold splice together firmly. Box nails can be used, just long enough to hold boards firmly together.

Leesville, S. C. F. E. BRODIE.

A.-C. Generator Design Determines if It Can Be Used for Synchronous Motor

ANSWERS to November Question 2

THE QUESTION

We have a 100-kva., 600-r.p.m., 480-volt, alternating-current generator that we wish to use as a synchronous motor, belted to a centrifugal pump. What changes if any are necessary in the machine to make it operate as a motor? If Power *readers have had experience with alternating-current generators operated as motors, I would appreciate knowing of their success or difficulties.*—B.A.S.

Motor Must Develop 40 Per Cent Starting Torque

SUCCESSFUL operation of a pump requires a starting torque of at least 20 per cent and a pull-in torque of not less than 40 per cent. Accordingly then, for the conditions of the problem, it is necessary to supply this synchronous machine with characteristics which will bring about the required torques.

The alternator is probably built without an amortisseur (squirrel-cage) winding, hence it must be provided with such a winding or an equivalent secondary circuit. In the event that the alternating-current generator is of an old design which has solid pole pieces, these will suffice for a secondary circuit and give the required torques. If the poles are laminated, it will be necessary to drill and equip them with a squirrel-cage winding. The bars can either be round or square, of ⅜-in. stock with particular attention given to joints between bars and end ring. It is necessary to make the pitch of the amortisseur winding at least 25 per cent different than the armature winding of the synchronous machine to prevent its locking in one position. Instances are on record where the burring of the laminated pole faces gave a secondary circuit sufficient to meet the required torques. A rough file drawn over the faces of the poles will make them function as a solid piece.

The field resistor should have 4 to 5 times the normal resistance of the generator field.

I would suggest starting the motor at not greater than 80 per cent of full voltage and that the stator winding be checked for rigidity. It may be necessary to bind the end turns of stator coils to the frame. It is not uncommon to convert alternators into motors, and by following the above suggestions B. A. S. should have no difficulty in bringing about the desired results.

WILLIAM R. DUNN,
San Francisco, Calif. Elliott Company.

Operation Will Depend on the Design of the Generator

THEORETICALLY, any alternating-current generator should operate as a synchronous motor once the machine is brought up to synchronous speed, the field excited and the stator connected to a source of electrical energy of the same voltage, phase and frequency as the machine delivers when operating as a generator. Practically, an alternator may or may not operate satisfactorily as a synchronous motor, depending upon the design of the machine and

characteristics of the load to which it may be connected.

If the pole faces of the alternator are provided with a damping winding similar to that of the squirrel-cage induction motor, it will probably operate satisfactorily as a synchronous motor, and develop sufficient torque to be self starting if the load during starting is light. This condition is met in B. A. S.'s proposed centrifugal-pump drive since the rotor may be brought up to speed with little mechanical load other than the friction of the motor and pump.

If the alternator pole faces do not have a damping winding, the machine will probably not operate satisfactorily as a synchronous motor. It may not be self starting, and even if brought up to synchronous speed by a separate source of power, there would be a pronounced tendency to hunt, that is, to swing above and below synchronous speed. It might even fall out of step with the power supply and stop.

Oklahoma City, Okla. J. H. BENDER.

Recommends Consulting the Generator Manufacturers

WHILE the unit may operate satisfactorily when it has been brought up to synchronous speed, the current required to give sufficient starting torque might be excessive. The latter may be true even at reduced voltage and may seriously affect service to other equipment. The starting current would be particularly high should it be necessary to start under load.

In my experience, a similar condition was solved by starting the motor unloaded, by a small belted motor, after which the unit was synchronized with the system as a generator. Operation was satisfactory except that the motor has a tendency to hunt under variable conditions. This machine was of the revolving field type built about 1910. The pole faces were not equipped with a squirrel-cage winding and the expense of making the change was not warranted. A rough estimate for the starting motor would be from 25 to 30 hp. for the machine to which B. A. S. refers.

Probably the safest method to assure a satisfactory result would be to communicate with the manufacturers of the generator giving the nameplate data for the machine as well as the duty characteristics of the pump and the load to be handled.

Brooklyn, N. Y.
C. O. VON DANNENBERG.

Generator Has Low Starting Torque When Operated as Motor

I WOULD ADVISE B. A. S. to consult Chapter VI of Hobart's "Design of Polyphase Motors and Generators." After reading this chapter I believe that he will be able to ascertain if the generator will operate successfully as a motor to drive the pump.

It has been my experience that a machine designed as a generator has very little starting torque when operated as a motor. If the generator in question is provided with magnetic end rings as suggested in Hobart's book, it should start and come up to speed. If the generator will start, there should be little difficulty in starting the centrifugal pump, because a large part of the load can be removed during starting by a valve in the discharge line, which is opened when the motor is synchronized. This valve should be closed while starting and opened gradually after motor has reached full speed.

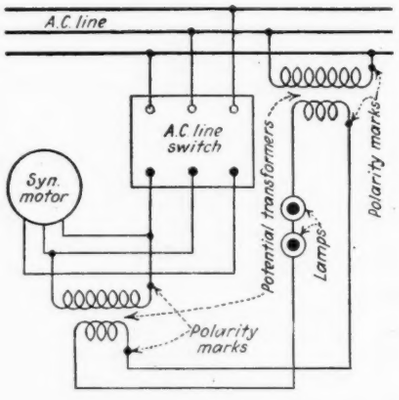
Birmingham, Ala. GRADY H. EMERSON.

Generator Should Operate Satisfactorily as a Motor

IF THERE is a damper winding in the pole faces of the generator, then there is no change necessary in the machine to operate it as a motor. It will have to be provided with a means of short-circuiting the field coil while starting and until the motor comes up to speed. It may be necessary to start the motor on reduced voltage. In case reduced voltage is used for starting, it is good practice to synchronize on this voltage and connect to full voltage afterward.

If the required starting torque is very low, a damper winding is not essential. To start an undamped synchronous motor, it is necessary, in some cases, to connect a high resistance across the field, say of about 300 ohms. Connect a double-throw, double-pole switch so that it can be used, one side of throw to connect the resistance across the field coils and the other throw to excite the field coils when the motor is up to speed and ready to synchronize. When starting, it may be necessary to increase the field resistance to bring the motor up to speed. One method is to set the field resistance at about $\frac{1}{3}$ of full value, then put power on the motor. When motor speed ceases to increase, which is likely to be at about $\frac{1}{3}$ to $\frac{2}{3}$ speed, then slowly cut in resistance. When it is up to speed, throw the field switch over to direct current. Do not use a heavy field current when synchronizing, bringing field current up to required value later.

If the machine has not sufficient starting torque, use a small induction motor to bring it up to speed and synchronism. Start the induction motor, then put sufficient field current on the synchronous motor to generate normal voltage. Watch the synchronizing device and voltmeter to see when the motor is up to speed and voltage. When these conditions are correct, close the alternating-current switch on synchronous motor.



If a synchronoscope is not available, two potential transformers and lamps connected as indicated in the diagram may be used. When the motor is nearly up to speed, the lamps will flicker on and off at longer and longer intervals until at exactly synchronous speed the lamps will remain bright or dark for appreciable periods. When the lamps are dark for a considerable period, the line switch may be closed while they are dark. Great care must be exercised to see that connections are correct.

Hamilton, Ont. J. RUSSELL CLUCAS.

Alternating-Current Generator Used for Dual Purpose

I KNOW of an engine-driven, alternating-current unit that is used as a generator on week days but is converted into a synchronous motor on Sundays. The object of this is to help carry the electric load when the plant is fully loaded through the week and to improve power factor on Sundays when the electric load is light. When operating as a motor, the generator is belted to a compressor.

If B.A.S.' alternator does not have a pole-face winding, it will not develop sufficient torque as a motor when starting. B.A.S. might do as in the case referred to, where no changes have been made in the generator. The machine is brought up to synchronous speed by the engine, which is disconnected by a clutch at the time that alternating current and excitation is supplied to the machine. Adjustment of the field current is made by the field rheostat.

Kingsport, Tenn. B. E. LINGAR.

Suggests Method of Starting the Synchronous Motor

ANY STANDARD alternator will operate as a synchronous motor. The difference in construction, if any, is that the latter has a squirrel-cage winding placed in the pole faces, which increases the starting torque and tends to prevent hunting while running. Most engine-type alternators of recent design are equipped with this winding.

The usual method of starting medium and high-speed synchronous motors is by a compensator similar to that used with induction motors. At starting, the field circuit is opened if the excitation voltage is 125 volts or less. If the excitation voltage is higher than 125 volts, the field switch should not be opened but left in the clips connected to the discharge resistance, to prevent abnormal induced voltage across the collector rings at starting. Starting voltage is applied to the stator winding, and when a speed near synchronous is reached, the field is excited and the motor will pull into step. The field current is then adjusted until the condition of minimum stator current is found or until the power-factor indicator records unity.

When a centrifugal pump is driven by a synchronous motor, the discharge valve should be closed before starting the motor so that the starting load may be as light as possible. The torque required at rest is usually from 16 to 22 per cent of full-load torque and drops to 5 or 6 per cent as soon as the machine starts turning over. Due to the water in the pump casing, the load increases to 40 or 50 per cent of full load value as the speed approaches synchronism.

Waynesboro, Va. J. M. MYERS.

THE ENGINEER'S BOOKSHELF

Air Conditioning

AIR CONDITIONING (1933)—*By J. A. Moyer, state director of University Extension in Massachusetts, and R. U. Fittz, assistant professor of Mechanical Engineering, Tufts College. Published by McGraw-Hill Book Co., 330 West 42d St., New York City. 390 pages, 6x9 in. Cloth. Illustrated. Price $4.*

This is the first complete treatment in one volume of the relatively new and growing subject of air conditioning. The book is primarily a text for engineering schools and engineers who wish to learn the fundamentals of air conditioning and the type of equipment available.

The first chapters deal with the theory of air conditioning and ventilation requirements. Two chapters are devoted to refrigeration and refrigerants, four to description and discussion of equipment. The remaining seven chapters discuss air conditioning for typical installations. Sample calculations are given for many of these installations.

It is, however, unfortunate that the authors have included practically no information on methods of distributing conditioned air in the condition spaces and methods of installing duct work. This is a very important subject, as the success of air-conditioning installations depends largely upon distribution of the cooled air supply without drafts. There also seems to have been omitted information necessary for calculating the heat transfer through building walls and windows from the warm outside air to the cooler conditioned space. With this information included, the text would have been complete in itself.

Selling Power

POWER SALES (1933). *By Dean Taylor. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y.; 206 pages, 5x7½ in. Cloth. Price, $2.*

Dedicated very frankly "to the power salesman who does not believe his company has all the power business to which it is entitled," this book is an extended treatment of several articles originally published in *Electrical World*. It is just what its title indicates—a compendium of successful sales methods used by central station salesmen. Chapters include, "What Makes a Power Salesman," "Where to Begin, or Find the 'No' Man First," "Objects of a Power Report When Odds are Against You," "Approach to an Untouched Market," "Payment Out of Savings," "Uniflow Engine Contracts," "Meeting Diesel Competition," "Retaining Existing Customers," "Yardsticks for Power Sales," and "Power Sales Management."

Some chapters of this book, particularly those on uniflow engine contracts and on meeting diesel competition, were the cause of much controversy at the time of their original publication as magazine articles. Many engineers outside the utility field vigorously attacked Mr. Taylor's presentation as one-sided.

Metallurgy

THE PRINCIPLES OF METALLURGY (1933)—*By Donald M. Liddell of Weld & Liddell, engineers, and Gilbert E. Doan, associate professor of Metallurgy, Lehigh University. Published by the McGraw-Hill Book Co., Inc., 330 West 42d St., New York City. 626 pages, 6x9 in. Cloth. Indexed and illustrated. Price $5.50.*

This is a basic and general text on metallurgy, so will be of interest to those power engineres dealing with metals and design. It is simple, readable and well arranged, so that it will also prove of value to consultants for basic reference data and to metallurgists as a handbook of processes and principles. It is unusually well illustrated.

The volume is divided into three parts; Materials Consumed in Metallurgy, Extractive Processes and Apparatus, and Physical Metallurgy. It is this 300-page third section which will be of interest to power men, particularly the 70-page Chapter 16 on Alloys and the three chapters immediately following on Properties as Related to Structure, Technology of Shaping Metals and other Physico-Metallurgical Processes.

Electrical Engineering

ELECTRICAL ENGINEERING PRACTICE, VOL. III *(Fourth Edition). By J. W. Meares and R. E. Neale. Published by Chapman & Hall, Ltd., 11 Henrietta St., London, England. 920 pages, 6x8½ in. Cloth; 282 illustrations; 112 tables. Price 30 shillings.*

Electrical engineering has attained tremendous proportions, as this volume indicates. It is the third of three written as a practical treatise for electrical, mechanical and civil engineers. Volume I contains 594 pages; volume II, 544 pages.

Volume III is a continuation of Part VI on power applications in Volume II and covers such subjects as electric motors and control for industrial applications, electric hoisting and conveying; electricity in mining and agriculture, electric traction, electric vehicles, electric propulsion of ships, chemical and metallurgical processes. Part VII includes specifications for different classes of electrical equipment, a discussion on depreciation and maintenance; methods of testing electric machines and circuits; and regulation as applied to the electrical industry in England.

The subject matter has been presented in a very practical and readable manner that makes the book valuable to both technical engineers and to electrical workers.

BRIEF REVIEWS

SMOKE AND SOOT POLLUTION ANALYSIS FOR THE CITY OF CINCINNATI. *Compiled by the Smoke Abatement League of Cincinnati, Hamilton County, Ohio, 2901 Union Central Building, Cincinnati, for the year July 1, 1932, to June 30, 1933.* Statistics on this subject for Cincinnati and environs collected by Frank H. Lamping, supervisor of the Smoke Abatement League. Copies available free.

RULES AND REGULATIONS COVERING FUEL-BURNING EQUIPMENT (1933). *Published by the Department of Smoke Regulation, Hudson County, N. J.* An 18-page booklet by Wm. G. Christy and John L. Hodges of the Hudson County Department of Smoke Regulation, Board of Health & Vital Statistics. Address as above to Court House, Jersey City, N. J. Supply postage.

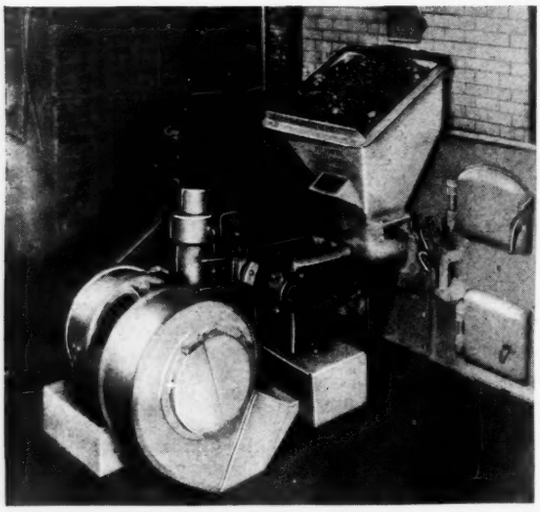
SMOKE (VOL. I, No. 1, Nov., 1933). *Official bulletin of the Smoke Prevention Assn., Inc., 139 N. Clark St., Chicago, Ill.* This initial issue marks revival of a campaign started 27 years ago to make the public smoke-conscious. Copies to any *Power* reader who will furnish postage.

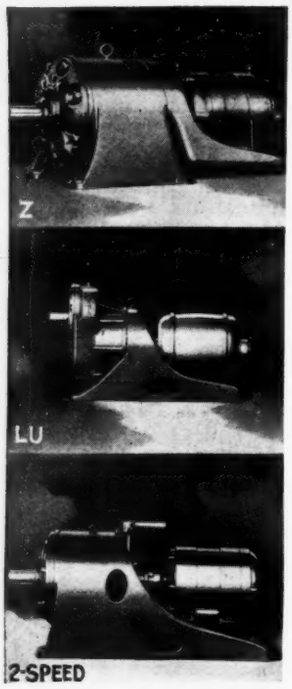
ELECTRIC LIGHT AND POWER INDUSTRY IN 1932. *Statistical Bulletin No. 9 of Edison Electric Institute, 420 Lexington Ave., New York City. Price 30 cents to members, 75 cents to non-members*—Tabulated data on central stations of the United States.

BEARING METAL DATA BOOK. *In loose-leaf form; published by Federal-Mogul Corp., Detroit, Mich. Free*—Results of a survey by technical men representing bearing manufacturers and research by Battelle Memorial Institute under auspices of Copper & Brass Research Ass'n. Data on 12 common bearing bronzes used by all manufacturers. New basis for bearing calculations and specifications, clearing up certain existing inconsistencies in standards and bettering specification limits.

ERMÜDUNGSFESTIGKEIT VON KESSELBAUSTOFFEN UND IHRE BEEINFLUSSUNG DURCH CHEMISCHE EINWIRKUNGEN (ENDURANCE STRENGH OF MATERIALS USED IN BOILER CONSTRUCTION AND THE EFFECT OF CHEMICAL AGENTS). *By Dr.-Ing. Cl. Holzhauer. (No. 3 of "Mitteilungen der Materialprüfungsanstalt an der Technischen Hochschule Darmstadt") Berlin, 1933. Published by VDI-Verlag G.m.b.H. Size DIN A5, IV173 pages with 54 illustrations and 6 numerical tables. Price, paper cover, 65 marks*—This treatise contains the first investigations on the effect of chemical influences on the endurance limit at elevated temperatures. The results afford a contribution to the subject of accelerating and retarding influences on the development of fatigue fractures in boiler materials, and serve to determine the conditions under which the various types of cracks develop.

WHAT'S NEW IN PLANT EQUIPMENT





Motoreducer

"Z" all-motor type, compact and rigid, yet permits use of any standard horizontal motor without change, including explosion-proof type. "LU" type single-reduction unit has all advantages of previous units. Two-speed motoreducer incorporates both speed range and speed reduction in single housing. A fourth unit, not illustrated, is a vertical motoreducer. Bulletin No. 270.

The Falk Corp., Milwaukee.

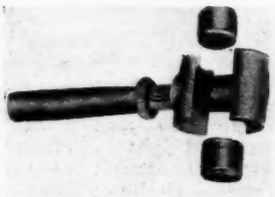
Underfeed Stoker

McHose underfeed stoker, ram type, designed for boilers of 800 sq.ft. to 3,000 sq.ft. of heating surface burning bituminous coal. Of heavy construction with few moving parts. Reduction drive-gear unit inclosed in oil-tight case requiring only occasional attention. Four Alemite grease cups, readily accessible, lubricate crankshaft and ram bearing. Shear pin at top of vertical drive shaft for quick access and replacement. Stoker equipment requires only about 5½ ft. of space in front of boiler, but no obstructions in front of ash door; 8-page bulletin.

James Beggs & Co., Inc., 165 Broadway, New York, N. Y.

Rawhide-Face Hammer

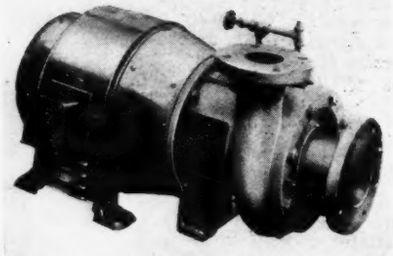
"Basa" hammer, with adjustable rawhide faces, has adjustable metal head to hold faces firmly, with jaws so recessed that faces are slightly mushroomed at back to hold them in. Rawhide faces replaceable. Interchangeable metal faces also available.

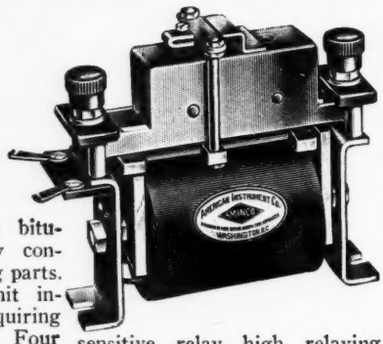


Greene, Tweed & Co., 109 Duane St., New York, N. Y.

Supersensitive Relay

For use with thermoregulators, contact-making instruments and other low-current devices. Operating current of 6.0 milliamp. at 6 volts d.c., or 0.0411 and a contact rating of 1,100 watts, give this supersensitive relay high relaying ratio of 24,000:1. High resistance of instrument coil makes it suitable for use with vacuum-tube relay circuits. Over-all dimensions 3⅜x3½x1¾ in. Coil rating 875 ohms, 6.9 milliamp., and 6 volts. Contact rating, 10 amp. at 110 volts, or 5 amp. at 220 volts, a.c. Available in normally open, normally closed, or single pole, double-throw model.





American Instrument Co., Inc., 774-776 Girard St., N. W., Washington, D. C.

Built-in Speed Reducers for Steam Turbine Drive

Built-in speed reducers makes it possible to obtain low speeds with usual high-speed steam turbines. Available with either single-reduction or double-reduction units, and for clockwise or counter-clockwise rotation. Compact. Herringbone gears exclusively. For use on pumps, blowers, mixers, etc.

Coppus Engineering Corp., Worcester, Mass.

Optical Pyrometers

Pyro optical pyrometer incorporates three separate direct-reading scales, one 1,400 deg. F. to 2,000 deg.; second 1,800 to 3,400 deg. (both standard calibration), and third, red-scale range from 2,200 to 3,600 deg. F. Self-contained, rugged and dustproof. No attachments or accessories. Master lamp for each checking furnished with each instrument. Bulletin.

The Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.

Motorpump Unit

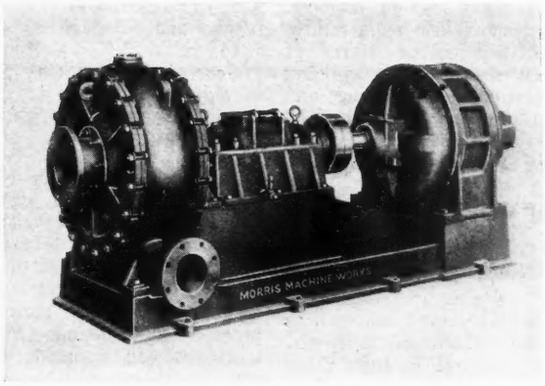
"Bilton" pump-and-motor unit has capacities from 20 to 500 g.p.m., and at 3,600 r.p.m. Heads 50 to 200 ft. Sizes up to 3 in. In single-phase, only 1, 1½ and 2 hp., 3,600 r.p.m., and 1 hp., 1,800 r.p.m., available. All sizes in 3-phase. Bronze impeller keyed to motor shaft and locked in position by lock screw and spring lock washer, to protect against reverse rotation of motor. Motor shaft protected by bronze sleeve to a stuffing box, and lantern ring for water sealing if desired. Pump case has case wearing ring mounted in suction cover for easy replacement. Slinger also mounted on shaft as additional protection to splashproof design. Pump case may be arranged to discharge vertically up or horizontally under or over. Standard unit has cast-iron case and bronze-fitted pump. Also, all-bronze units, all KA2, including stainless-steel motor shaft, in special open runner and explosion-proof motor types.

Byron-Jackson Co., Berkeley, Calif.

Automatic Cleaning Machine

Model D "Hypressure Jenny" is automatic. Same essential principle as previous models—generates vapor blast, combining in any desired proportions basic requisites for thorough cleaning. Motor driven, operating on lighting current. Heat generated by fuel-oil burner of pressure-atomizing type. Ignition by electric spark. Self-contained and designed for one-man operation. Rotary solution, water and fuel-oil pumps, direct-connected to ¼-hp. motor. Saturation selector permits operator to obtain any degree of vapor saturation desired. Pressure carried on generator quickly adjustable from 50 to 175 lb. Nozzle control permits continuous automatic operation without attendance. Motor, generator pumps and fire start when vapor outlet is opened, and stop when it is closed.

Homestead Valve Mfg. Co., Coraopolis, Pa.



Heavy-Duty, High-Head Pump

Type F centrifugal is specially developed for handling extremely abrasive mixtures against high heads. All parts subject to wear semi-steel, manganese steel, or special alloy, depending on service. Large-diameter casing and impeller permit pump to run at comparatively low speeds even against high heads. Impeller position can be adjusted from outside of pump to take up wear on suction sealing rings and prevent internal leakage. All parts heavy for strength and rigidity, and those subject to greatest wear designed to permit quick and economical replacement. Especially adapted to ash disposal, coal handling and process work. Complete range of sizes from 4-in. to 15-in. discharge for total heads up to 150 ft., and for operation by electric motor or belt.

Morris Machine Works, Baldwinsville, N. Y.

Boiler Tube Cleaner

B. E. T. cleaner has double arms to reduce time and eliminate cleaning or wiping of rods. No swinging or sliding joints, no carriage, no head. Screw rod in coolest part of boiler, near front. Supporting bar and rod near front leaves clear passage for gases to stack. All nozzle arm joints welded. Flexible stainless steel steam connection. Supports attached to extended shell of boiler or to front above doors, leaving doors free from attachment and all tubes uncovered and unrestricted. Nozzles 4 in. out from tube ends, and travel in a straight line across centers of tubes. This causes entrainment of more than 17 lb. of gas per lb. of steam. Confinement of jets (forcing all expansion of steam to take place in straight line) increases velocity.

Boiler Equipment Trust, North Amherst, Mass.

Abrasion-Resisting Cast Iron

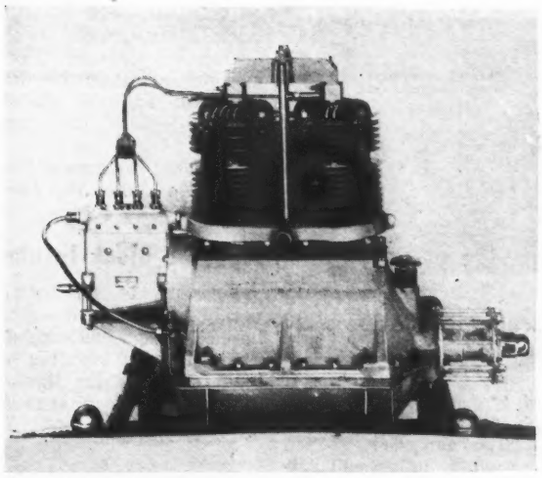
Super Manga abrasion-resisting alloy cast iron is a nickel chromium alloy for use in units handling coke and other abrasive agents. Wear tests indicate two to twelve times longer life than plain chilled iron. Bulletin No. 87.

Robins Conveying Belt Co., 15 Park Row, New York, N. Y.

Two-Cycle, Sleeve-Valve Diesel

Howell 100-hp. (estimated) two-cycle, 5x6-in., single sleeve-valve diesel runs at 1,800 r.p.m. (maximum 2,000). Air-cooled, but can be converted for chemical or water cooling. Uses separate Root-type scavenging blower, and has full-pressure lubrication. Bosch fuel pump, runs at half speed, using two plungers per cylinder alternately. Spray nozzles are also Bosch, at 4,000 lb. Five-hole type with 120-deg. spray angle. Cylinder head hemispherical with nozzle in center. Piston conical type slightly curved inward. Lubrication by force feed; special gear pump driven at engine speed with means for controlling pressure. Built-in Cuno oil strainer. Sleeve valve eccentrics machined integral with crankshaft. Two bronze connecting rods operate sleeve valve, one on each side, to prevent twist and strain. Weight per horsepower 3⅛ lb.

Hooper Machine Co., 12-12—44th Ave., Long Island City, N. Y.



Weatherproof Outlet

This outlet has flush plate with solid rubber pad on back, insuring snug fit when device is screwed into place. Cap slips over cord plug and screws onto plate for weatherproof connections. Another rubber-insulated cap, chained to flush plate, screws over outlet when not in use. Parts brass, cadmium plated.

General Electric Co., Schenectady, N. Y.

Arc Arrester

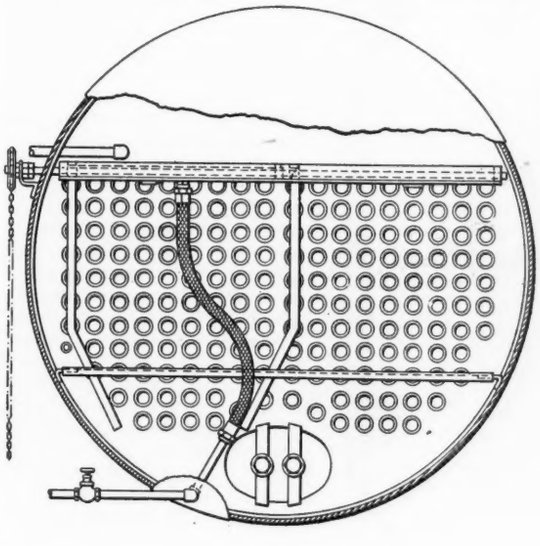
This unit, for mounting on base of contactor or line starter, includes a small capacitor and resistor connected across poles on load side of contacting device. Speeds a.-c. arc extinction without introducing mechanical devices. Oscillograms show less than one-half cycle arcing with arc arrester as against five to eight half cycles without it under otherwise identical conditions.

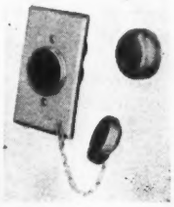
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

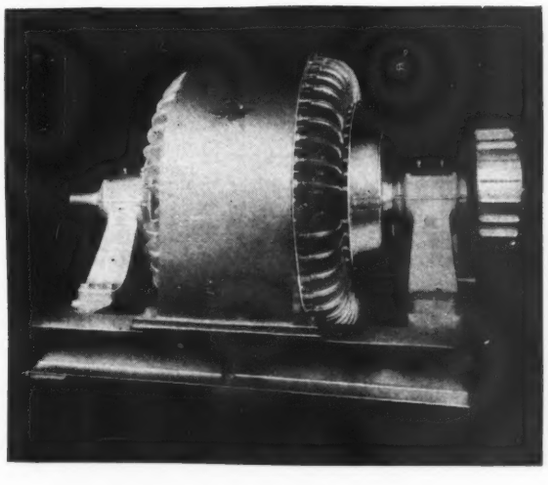
Totally Inclosed, Synchronous Motor

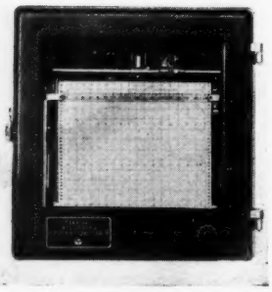
Designed for use where corrosive atmospheres prevail, or where motors are subject to salt water or other sprays, this totally-inclosed fan-cooled synchronous motor is sealed from exterior atmosphere and outer surfaces are treated to prevent corrosion. Cooling secured by internal recirculation of air.

Electric Machinery Mfg. Co., Minneapolis, Minn.









Recording Potentiometer Pyrometer

New type balancing mechanism so designed that it produces large movement of pen or print wheel for a small galvanometer deflection and moves printing mechanism quickly from one end of scale to other, without requiring fast cycle or rapid motion of mechanism. Consists essentially of V-shaped cam drive and friction roller. Sensing fingers, which detect galvanometer deflection, position friction roller according to position of galvanometer pointer. V-shaped drive cam then engages and rotates roller, which in turn transmits its straight-line motion to slide-wire contact, moving it a corresponding distance. Pen or print wheel being mounted integrally with slide-wire contact, moves with it, thus making record coincide with measurement. Record dots are square in shape, each record being identified by different color. Just below upper chart roller, chart passes under scale plate of transparent unbreakable material with scale graduations engraved on it, thus making temperature values of chart lines easily read. Bulletin 190.

The Foxboro Co., Foxboro, Mass.

Graphite Lubricant

Ideal "Kant-Rust" penetrating graphite lubricant is available in eight different sizes of containers, from 3-oz. handy can to 55-gal. drum. Can be used to release pulleys from shafting, Woodruff keys, rusty nuts and bolts, expansion taps and dies, and to prevent rust and corrosion generally.

Ideal Commutator Dresser Co., Sycamore, Ill.

Recording and Indicating Flow Meters

"Foto-Flo" meter has no moving parts, no intricate mechanisms. Principle is that of common mercury manometer actuated by differential produced by means of orifice in flow lines. Direct-recording. Flow is recorded by light rays on sensitized paper chart, rays being obstructed by one side of mercury column. For immediate indication of flow, a calibrated scale is placed on opposite side of mercury column.

Trimount Instrument Co., 332 South La Salle St., Chicago, Ill.

Pipe and Block Insulation

Resistant to moisture, this packing simply dries out unharmed. High efficiency makes it suitable for both high- and low-pressure steam lines and saves thickness in installation.

Easily cut to shape or length, is light, non-sagging and non-crumbling. Standard molded-type shapes and sizes. Blocks shipped in cases, pipe insulation in cases complete with canvas and brass lacquered bands.

Refractory & Engrg. Corp., 381 Fourth Ave., New York City.

Furnace Draft Regulator

Type HF-1 furnace draft regulator is used primarily to control combustion-chamber draft in a boiler plant. Can also be used to control fan speed or ventilating-system pressures or drafts. Fundamental principle

that of beam scale, "weighing" draft until desired amount is secured, then maintaining it. No diaphragm used. Construction same as in larger regulator of same company. Suitable for boilers up to 2,000 sq.ft.

Carrick Engineering Co., P. O. Box 299, Michigan City, Ind.

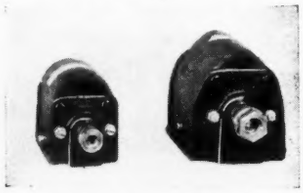
Time and Temperature Controller

"Thermochron" combines time and temperature functions to anticipate temperature changes without artificial heating of thermostat. Fractional temperature drop causes heat to be turned on 1 or 2 to 20 min. or continuously, depending upon rate of heat loss of building. Will maintain temperatures within fraction of degree of pointer setting, thus avoiding overheating, underheating and air stratification. Bulletin T-26.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Fluid Valve

This electrically operated fluid valve handles small or large volumes of compressed air and other mediums such as gasoline, water, oil and gas. Energizing coil through push-button will open valve and allow fluid to flow to operate a whistle

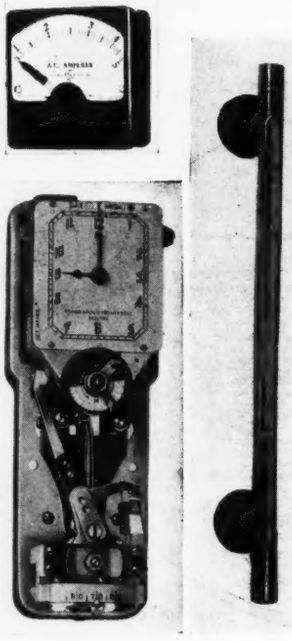


or other device. Or coil may be engaged continuously to hold valve open, and should power to circuit fail, valve closes automatically. Three sizes.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Rectangular Switchboard Instruments

Scale can be read at an angle in these instruments without error of parallax. Antiglare glass, magnetic damping, high torque, responsiveness, permanently constant characteristics and three styles of cases are other features. Line, including Types AD-6 and DD-6 includes a.c. voltmeters, ammeters, wattmeters, P.F. meters and frequency meters, and d.c. ammeters and voltmeters. Also special instruments, surface



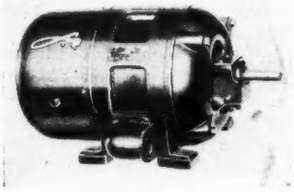
(6x5½ in.) and flush (7x6½ in.) types and 3-element types 12x5½ in.

General Electric Co., Schenectady, N. Y.

Rust Preventive

Stonhard Rustproofer comes in liquid form and can be either brushed or sprayed over new or rusted metal surfaces. When applied to rusted surface, stops rusting immediately, and forms non-porous, moisture-proof, air-tight coating. Original treatment can be made finish coat by single application. Aluminum powder, powdered graphite or dry red lead may be mixed with this compound and applied to rusted metal surfaces for dual effect.

Stonhard Co., 401 N. Broad St., Philadelphia, Pa.



Self-Contained Capacitor Motor

This line of capacitor-start, single-phase motors has built-in capacitor and automatic cut-out switch. Capacitor of coil-wound type without sharp turns, placed so that air circulates constantly between it and motor. Cut-out switch is unaffected by voltage variation or starting-load variations. Sizes ⅓ to 3 hp. in either horizontal or vertical types; other sizes soon to be added. Bulletin 514.

Louis Allis Co., Milwaukee, Wis.

Fluid Gages

Three new lines of gages for measuring liquid levels and various pressures. Innco Fluidgage operates on hydrostatic principle, three liquids being available for various scale readings and heads. Innco Recuperator gages, illustrated, suitable for liquid levels or pressures and operating on recuperator principle, may be had in variety of ranges and scales for various pressures. Innco Resistogage operates on electrical-resistance principle. May be had in wide range of scales and pressures. A number of gages may be read at a remote point on single meter. Particularly adaptable to breweries and industrial plants having a large number of tanks or pressures to control or record from a central point.

Ess Instrument Co., 30 Church St., New York City.

POWER LINES

Announce Technical Program for A.I.E.E. Winter Convention

The technical program for the forthcoming winter convention of the American Institute of Electrical Engineers, in the Engineering Societies Bldg., 29 West 39th St., New York, N. Y., Jan. 23-26, includes papers on Hudson Ave., Richmond, Long Beach Steam Plant No. 3, Conners Creek, and State Line stations.

J. Allen Johnson, chief electrical engineer, Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y., has been nominated for president. Vice-presidential nominees include: W. H. Timbie, professor of electrical engineering, Massachusetts Institute of Technology; R. H. Tapscott, vice-president, New York Edison Co.; G. G. Post, vice-president, Milwaukee Electric Railway & Light Co.; F. J. Meyer, vice-president in charge of operation, Oklahoma Gas & Electric Co.; F. O. McMillan, research professor of electrical engineering, Oregon State College. Nominees for directorships include: F. Malcolm Farmer, vice-president and chief engineer, Electrical Testing Laboratories; Nevin E. Funk, vice-president in charge of engineering, Philadelphia Electric Co.; and H. B. Gear, assistant to the vice-president, Commonwealth Edison Co., Chicago.

Used Equipment Dealers Form National Association

Numerous meetings, both local and national, of dealers in used machinery and equipment of all kinds, were crystallized at a meeting in Pittsburgh, Dec. 9, in formation of the National Association of Used Machinery and Equipment Dealers. By-laws have been adopted and a code prepared to be submitted to Washington shortly. Officers are: M. D. Galbreath, president, 58 Water St., Pittsburgh, Pa., Samuel A. de Witt, vice-president, 252 Lafayette St., New York, N. Y., and C. L. McDonald, treasurer, 1531 N. Broadway, St. Louis, Mo. J. D. Crawbuck, 406 Empire Bldg., Pittsburgh, represents electrical equipment on the Board of Directors, and Hy. F. Sachsemmaier, Ashburner and Hegerman Sts., Holmesburg, Philadelphia, represents power equipment.

Mechanical Improvements Rate Public Money

After conferring directly with the Public Works Administration, *Power* is able to announce the following as an expression of P.W.A. policy:

Modernization of public buildings and institutions is eligible for financing by the Public Works Administration. Numerous applications of this character have been approved which represent substantial capital improvements in heating and ventilating, plumbing, elevators, sprinkler systems and other fire control and fireproofing installations, refrigeration and air conditioning. PWA does not invite applications for small loans for such purposes as it is not equipped to handle them and an attempt to do so not only would increase administrative expense but delay handling of applications on major projects. Equipment suppliers should contact with states and municipalities with whom projects initiate. All applications forwarded by PWA state engineers are considered in Washington on their individual merits. Grants representing 30 per cent of the cost of labor and materials and loans for the remainder of the total cost, are made on approved projects, with 4 per cent general obligation bonds as security.

Turbine-Generator Explodes

Apparently caused by over-speed, the 3,600-r.p.m. turbine-generator, furnishing 750 kw. of power for American Beet Sugar Co. at its Mason City, Iowa, plant, exploded Tuesday, Dec. 19, killing the master mechanic and injuring three operators. All charts in the engine room were uniform, so overspeed is believed the only thing that could have caused the accident. The force of the explosion shattered the steel casting encasing the generator, but left the steam section intact.

EXHIBITORS COMMITTEE

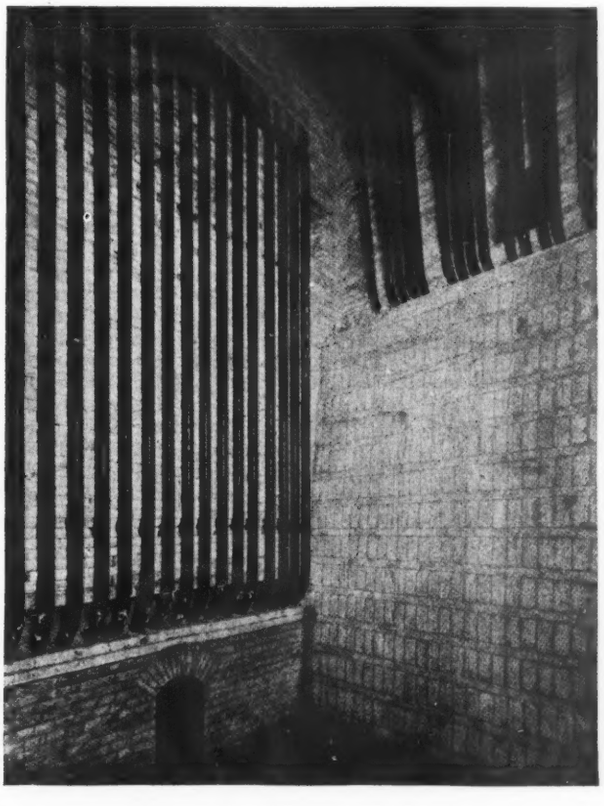
At the annual meeting of the Board of Directors of the Exhibitors Committee, E. J. Billings, of Babcock & Wilcox Co., was elected to serve as president in 1934. L. W. Shugg, of General Electric Co., was elected vice-president; F. C. Kerns, of the Texas Co., secretary; J. P. Ferguson, of Reading, Pratt & Cady Co., Inc., treasurer, and W. A. Hemming, of the Exhibitors Committee, executive secretary. This committee, which is entering its ninth year, is a service organization for industrial and trade show exhibitors. It maintains comprehensive data and information on all types of shows at its headquarters, 330 West 42d St., New York, N. Y.

Power Conference Papers Available

Transactions of the 1933 Scandinavian Sectional Meeting of the World Power Conference and of the First Congress of the International Commission on Large Dams (also World Power Conference), may now be obtained in bound form by American readers from the American Committee, World Power Conference, 1419 Chrysler Bldg., New York, N. Y. Prices, F.O.B. New York, are $50.00 for the seven volumes of the Sectional Meeting Transactions and $22.50 for the five volumes of the Transactions of the Commission on Large Dams. The volumes may also be purchased separately. It is understood that a discount of 20 per cent, applicable up to Dec. 31, 1933, may be extended to the end of January.

Canadian Engineering Institute Meets Next Month

The 48th annual general and general professional meeting of the Engineering Institute of Canada will be held in Montreal, Feb. 8 and 9, with headquarters at the Windsor Hotel. Two technical sessions will be included, both the second day. The first day will be given over to business meetings.



Interior of furnace under 6,680-sq.ft. Heine boiler at Pillsbury Flour Mills. At left is the bare-tube, water-cooled side-wall. At right is the rear wall, the lower portion of sectionally supported, air-cooled refractory, with a radiant superheater protecting the top

A.S.H.V.E. Celebrates Fortieth Anniversary at Annual Meeting Next Month

The A.S.H.V.E. will celebrate its fortieth anniversary at its annual meeting at the Hotel Biltmore, New York, N. Y., Feb. 5 to 8. Concurrently, the third International Heating & Ventilating Exposition will be running at Grand Central Palace.

The technical program includes papers on such subjects as solar radiation, hot-water circulation, warm-air heating system control, and a series of reports on conditioning homes where various types of heating, humidifying and cooling equipment are used. One session will be devoted largely to a discussion of the medical viewpoint on air conditioning, and will present a series of studies. Investigation of boiler performance, electric heating, and description of a new research laboratory will also be included. Technical sessions will be held each day.

More informative displays will be the feature of the Heating and Ventilating Exposition. One exhibitor will show a glass model of a steam trap operating at 5 lb. pressure, showing how the trap handles air and sludge, as well as condensate, another, an automatic by-pass for quick heating of units containing large volumes of air. A boiler company will exhibit two steel heating boilers, one designed exclusively for oil burning, containing extra features for draft control and for domestic hot water supply; the other for larger residences and the smaller public and commercial buildings. Provision is made for refuse disposal and for an auxiliary grate for stand-by heating. Another exhibitor will show a complete line of indirect water heaters, designed for connection to a heating boiler, or to be installed within the heating boiler itself or in special headers or storage tanks. There will also be a complete new line of oil burners, stacks, safety combustion control, flow control systems, pressure reducing valves, and similar equipment.

Leipzig Trade Fair Planned from March 4 to 11

Over 7,000 exhibits, an increase of 15 per cent over last year, will be shown at the next Leipzig Fair. It is already assured that 22 countries will send exhibits, and buyers will be assembled from 70 countries, for the Fair from March 4 to 11. American headquarters are: Leipzig Trade Fair, 10 East 40th St., New York, N. Y.

News Notes

An average saving of $73,000 per year in the operation of state-owned power plants has been effected in the past six years by Adolph Wagner, supervisor of Virginia state power plants, according to a recent announcement. Economies are said to come about as a result of changes in method of operation and replacement of obsolete equipment. The 1926 survey disclosed out-of-date equipment, boilers set so low as to prevent complete combustion, and inadequate furnace capacity for use of high-volatile Virginia coal. Up to July 1 of last year, 11 institutional power plants had been improved, showing a saving of over 29 per cent of the usual coal tonnage. Savings effected paid for improvements in less than two years.

The American Society for Testing Materials has moved its headquarters from the Engineers' Club Bldg., 1315 Spruce St., Philadelphia, to larger offices in the Atlantic Bldg., 260 South Broad St. Total floor area has been increased 40 per cent, while general office space is nearly 60 per cent greater.

Johnson Corp., Three Rivers, Mich., has appointed the following representatives: Advance Engineering Co., 69 Dey St., New York, N. Y.; Barrett-Christie Co., 108-112 N. Clinton St., Chicago, Ill.; Brogan & Company, 810 Race St., Philadelphia, Pa., for the company's line of water heaters and air separators and aftercoolers.

Bristol Co., Waterbury, Conn., has organized a separate company, the Bristol Company of Canada, Ltd., with factory and general headquarters at 64 Princess St., Toronto, Ont. J. S. Mayberry, for ten years with the parent company, has been appointed manager.

Morse Chain Co., a division of Borg-Warner Corporation, Ithaca and Detroit, has acquired the Kelpo free-wheeling or one-way industrial clutch, formerly a product of Kelpo Clutch Co., Rockford, Ill. The clutch will be manufactured at the Ithaca plant.

John Ripley Freeman, who was awarded the John Fritz Medal for 1934, Oct. 20, died before final procedure in selecting the medal list had been completed. Consequently, the presentation will be made to one of his sons, Jan. 17, in connection with the annual meeting of the A.S.C.E. in the Engineering Societies Bldg., 29 West 39th St., New York, N. Y. The medallist was a past-president and an honorary member of both the A.S.C.E. and A.S.M.E. The John Fritz Medal is the highest honor bestowed by the engineers of America.

OBITUARIES

Thomas P. Bradley, for thirty years attached to the steam engineering department of the Brooklyn Navy Yard prior to his retirement a few years ago, died at his home in West Newton, Mass., Nov. 30.

Arthur Eugene Brady, 58, vice-president and treasurer of Jenkins Brothers, 80 White St., New York, N. Y., died at his home there Nov. 4. He had been in poor health for several years. He joined Jenkins in 1893, beginning as junior clerk.

Harold L. Goodwin, 36, a member of the engineering staff, Generating Department, Edison Electric Illuminating Co., Boston, died Dec. 4 at Symmes Hospital, Arlington, Mass., after a week's illness. He had been with the Edison company for about five years, was educated at the Massachusetts Institute of Technology, and was for a time employed as a construction engineer by the Stone & Webster Engineering Corporation.

Kenneth A. McRae, 62, stationary engineer of the Imperial Life Assurance Co., and teacher in engineering and electricity at the Central Technical School, Toronto, Ont., died recently. He had been with the company for 22 years, and had first-class engineer's papers.

Clifford F. Messinger, 44, president of Chain Belt Co., Milwaukee, died suddenly Dec. 12, from a heart attack. He entered the service of Chain Belt in 1911, and has successively held the offices of advertising manager, sales manager, general manager, vice-president and president. He was elected to the presidency in December, 1930. He was also a director of Chain Belt, Interstate Drop Forge Co., Sivyer Steel Casting Co., and Federal Malleable Iron Co., all of Milwaukee. He was also president and director of Stearns Conveyor Co., Cleveland.

Robert Henry Smith, 71, professor emeritus at Massachusetts Institute of Technology, and for 47 years a member of the mechanical engineering department staff, died at his home in Watertown, Mass., Dec. 11.

Joseph H. Walcott, 44, for the past five years plant engineer of Seth Thomas Clock Company, Thomaston, Ct., died at his home in that city on Dec. 13. He was a native of Danvers, Mass., and previous to his recent connection had been plant engineer of Helburn-Thompson Co., Salem, Mass., for seven years.

Henry H. Westinghouse, chairman of the Board of Directors of the Westinghouse Air Brake Co., and an outstanding mechanical engineer, died recently in Goshen, N. Y. He had celebrated his 80th birthday just previously.

POWER'S HISTORY

POWER was founded in 1884 by E. P. Harris and H. M. Swetland. With it was incorporated *Steam*, which had been started by N. Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine*.

In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer*. When *The Engineer* was purchased the name of the combined paper was *Power and The Engineer*. The title was condensed to *Power* in 1911.

Ownership of *Power* passed from E. P. Harris to H. M. Swetland and James H. McGraw, then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company, in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of *Power*. Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin Van Winkle. F. R. Low was editor from 1888 until Dec. 31, 1929. Ely C. Hutchinson was editor from Jan. 1, 1930, to Feb. 1, 1933.

The present staff consists of P. W. Swain, editor; F. R. Low, editor emeritus; F. A. Annett, R. B. Purdy and E. J. Tangerman, editorial staff.

STRAWS

Pointing the way the business wind blows

Virginia Electric & Power Co., has completed installation of a steam service to Brown's Island Mill of Albemarle Paper Mfg. Co., Richmond, Va. Heretofore, Albemarle has manufactured its own steam. The mill is 2,100 ft. west of the 12th Street plant of the power company, and is joined by a 12-in. steam pipe and 4-in. return pipe. Under present operating conditions, the paper mill uses about 25 million pounds of steam per month, average hourly flow being 40,000 lb. Approximately 21 million pounds of condensate is returned to the 12th Street plant. The heat loss in passage through the insulated pipes is said to be less than 0.5 per cent.

Applications for Federal grants and loans for municipal electric light and power plants have been filed by a number of cities and towns in Oklahoma. Norman proposes a fund of $600,000 for such a project, including electrical distributing system, and plans have been completed by J. H. Bender, 827 N. W. 32nd St., Oklahoma City, consulting engineer. Frederick plans a new municipal generating plant to cost $165,000, with equipment. Morris has applied for an appropriation of $105,000 for a municipal electric light and power plant. Woodward expects to receive a grant and loan of $290,000 for new power plant and has had plans drawn for the station. Chandler has plans for a municipal light and power plant to cost $130,000, with equipment, of which $36,000 will be a Federal grant and $94,000 a loan. Benham Engineering Co., Dierks Bldg., Kansas City, Mo., is engineer. Geary has made application for financing for $75,000 for a municipal power plant. Pauls Valley estimates a proposed electric light and power plant to cost $257,000, of which $200,000 will be a Federal loan and the balance a Federal grant. Temple seeks $60,000 for a municipal light and power project. Hominy has applied for a loan and grant totaling $195,000 for an electric light and power plant, and municipal distribution system. Wynnewood proposes to build an electric light and power station to cost $65,000. Cushing has secured a Federal grant and loan of $350,000 for a new municipal power plant and will complete plans at once. Neil Barde is city engineer in charge. Stigler seeks a Federal appropriation of $65,000 for a new light and power plant.

A power plant and waterworks station to cost $940,000, with equipment including pipe-line construction, will be built by Mathieson Alkali Works, Inc., 250 Park Ave., New York, N. Y., at new soda ash and caustic soda plants at Lake Charles, La., where tract of over 100 acres of land recently was purchased. A large electric-operated pumping plant will be built for water service and another such station for brine supply; brine pipe line and operating facilities from company salt properties in West Hackberry district will cost about $545,000 in addition to sum noted. Plant is scheduled for completion in twelve months and will represent an investment of approximately $7,000,000. Stone & Webster Engineering Corp., New York, N. Y., will supervise building construction.

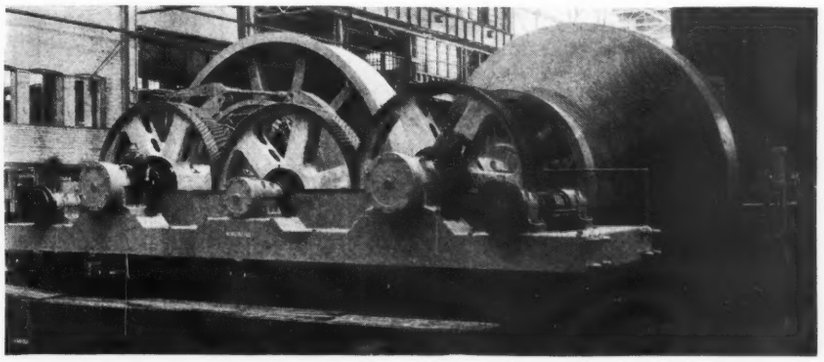
Blue Creek Public Power and Irrigation District, Lewellen, Neb., is reorganized under the direction of E. E. Richards, Oshkosh, Neb., attorney, to carry out a hydro-electric power and irrigation project on Blue Creek, about 5 mi. from Lewellen, with irrigation system in parts of Garden, Keith and Morrill Counties. Estimated to cost about $400,000, and application for Federal aid will soon be made.

Hiram Walker & Sons, Inc., through the engineers, Smith, Hinchman & Grylls, have placed an order for the Neckar process of boiler feed-water treatment for the new distillery at Peoria, Ill. The system will have capacity to treat 150,000 lb. of raw water per hour.

Work has been started on the municipal power and light plants at Culpeper, Va. Town officials are planning to issue general obligation bonds immediately for $120,000.

Columbia Power Co. is to begin installation of a new diesel power plant at Smithers, B. C., to take over the business and assets of Smithers Electric, Ltd.

Plans for a hydro-electric generating plant are under way by the Spartanburg Water Commission, Spartanburg, S. C., in conjunction with a flood control project on the Pacolet River. A power dam about 50 ft. high will be built on the river noted at point about 7 mi. from city. Entire program will cost $630,000, and application is being made for Federal aid in that amount. R. B. Simms is superintendent of waterworks, in charge.



HERRINGBONE-GEAR DRIVE IN HUGE MINE HOIST

Two of the largest gears so far used for mine hoists are 12 ft. in diameter with 30-in. face. They are on two double-conical drum hoists just built for Homestake Mining Co., Lead, S. D., by Nordberg. Each hoist covers 56 x 61 ft. of floor space, and has drums 25 ft. in diameter at the large end. Each hoist will wind 5,400 ft. of 1¼-in. rope, hoisting a load of 14,000 lb., total rope pull being 57,000 lb. Each drum weighs 210,000 lb. Two 1,500-hp. G. E. motors drive each hoist, and flywheel-type motor-generator sets are also included

FEDERAL ALLOTMENTS

New allotments by the Public Works Administrator, Harold L. Ickes, include the following:

A loan and grant for $170,000 to Culpeper, Va., for construction of a diesel-engine generating plant and complete distribution and street lighting system. 30 per cent of cost of labor and material, approximately $125,000, is a grant.

Loan and grant of $350,000 to Cushing, Payne County, Okla., for construction of municipal power plant, including installation of three 500-kw. diesel-driven generators and complete electric distribution system; 30 per cent of cost of labor and material, approximately $280,000, is a grant.

Loan and grant for $95,000 to the City of Grand Haven, Mich., for installation of an additional 800-kw. diesel-driven generator in existing power plant. Approximate cost of labor and material is $72,000, of which 30 per cent is a grant.

Loan of $45,000 to Conway Corp., Conway, Ark., a private corporation, for removal of existing 150-kw. steam generating unit and installation of 600-kw. diesel-generating unit.

Covington, Va., has applied to the Virginia State Advisory Board of the P.W.A. for a loan and grant of $402,065 to construct a municipal power plant.

Loan of $336,000 to Huron Road Hospital, Cleveland, Ohio, a private corporation, for completing hospital building and power plant.

Loan and grant for $100,000 to Commonwealth of Massachusetts for running steam lines and returns from existing boiler house to various isolated building units at Monson State Hospital, Monson, Mass. 30 per cent of cost of labor and material, approximately $81,000, is a grant.

Grant of $300 to City of Blackwell, Okla., to aid in construction of an additional 25 ft. to the smokestack of present electric power plant. No loan requested.

Loan and grant for $400,000 to City of Austin, Travis County, Tex., for installation of 7,500-kw. turbo-generator with necessary auxiliaries, two 30-ton turbine cranes, repairs to settings of three boilers, construction of a 6,000,000-gal. settling basin, and alterations to treatment building for water system. 30 per cent of cost of labor and material, approximately $325,000, is a grant.

Grant of $255,000 to State of New York to aid in construction of several buildings and power-plant equipment at Newark State School, Newark, Green County, N. Y. No loan requested.

Grant of $24,000 to Borough of Chambersburg, Pa., to aid in installation of 2,500-kw. turbo-generator with condensers, air cooler and accessories. No loan requested. Allotment represents 30 per cent of cost of labor and material of project, of which total cost is $103,000.

Loan of $380,000 to Fort Pierce Development Co., Fort Pierce, Fla., a private corporation, for construction of cold-storage warehouse and power plant and improvement and addition to an existing dock.

Grant of $1,000 to Bellevue Independent School District, Jackson County, Iowa, to aid in renewal of boiler and heating system for grade and high school. No loan requested.

Loan and grant of $410,000 to City of Allegan, Mich., for construction of an electric power plant, including completion of a dam across Kalamazoo River, installation of one 1,125-kw. and one 563-kva. vertical waterwheel generator, power house, and complete distribution system. Approximate cost of labor and material is $295,000, of which 30 per cent is a grant.

Loan and grant for $35,000 to Commonwealth of Massachusetts for removal of fire-tube boilers and settings from Norfolk Prison Colony and installing same on suspension-type supports at Rutland State Sanatorium, including fuel-oil equipment. 30 per cent of labor and material, totaling approximately $27,800, is a grant.

AIR CONDITIONING

Allotment of $1,000,000 to provide for air-conditioning public buildings in Washington, D. C. Buildings have not yet been designated, but will be selected from permanent structures where working conditions have been found intolerable.

Grant of $70,200 to St. Louis County, Mo., to aid in construction of four-story fireproof addition to present St. Louis County Hospital, and replacement of present refrigerating unit with larger at Clayton, Mo. Allotment represents 30 per cent of cost of labor and material on project; total cost is $285,342.

PUMPING EQUIPMENT

EAST

Loan and grant of $40,000 to the Commonwealth of Massachusetts for installation of automatic sprinkler, gas pipe and fire pump at Reformatory for Women, Framingham, Mass. 30 per cent of cost of labor and materials, approximately $32,600, is a grant.

Loan and grant for $97,000 for Commonwealth of Massachusetts, for construction of 4,200 sprinklers, 1,000,000-gal. tank, 1,000 ft. fireproof piping, and connections at State Farm, Bridgewater, Mass. 30 per cent of cost of labor and material, approximately $77,000, is a grant.

Loan and grant of $22,000 to Borough of Glen Rock, Bergen County, N. J., for extension of intercepting sewer, including new pumping station and receiving tank. 30 per cent of cost of labor and material, approximately $4,800, is a grant.

Loan and grant of $1,650,000 for County of Onondaga, New York State, for construction of intercepting sanitary sewer, sewage treatment plant and pumping station. Approximate cost of labor and material is $1,173,000, of which 30 per cent is a grant.

Loan and grant of $81,000 to town of Holland, Erie County, N. Y., for purchase of a franchise from a private water company, drilling two wells, installation of pumping equipment, and similar work. Cost of labor and material is $55,000, of which 30 per cent is a grant.

MIDWEST

Grant of $45,000 to City of Janesville, Rock County, Wis., to aid in construction of a complete sewage-treatment plant, including pumping station. No loan requested.

Grant and loan for $265,000, which is a reallotment to City of Eau Claire, Wis., for a new water supply, together with necessary pump houses. Approximate cost of labor and material is $230,000, of which 30 per cent is a grant.

Loan and grant for $37,000 to City of Gardner, Kan., for construction of a water-works system, including well and pumping equipment. Approximate cost of labor and material is $30,000, of which 30 per cent is a grant.

Loan and grant for $72,000 to Savannah, Carroll County, Ill., for construction of two wells and pump house, repairs to reservoir, and similar work. 30 per cent of cost of labor and material, approximately $55,000, is a grant.

Loan and grant of $110,000 to City of Anna, Union County, Ill., for use in drilling wells and installation of pumping equipment, softening equipment, piping and construction of a small pumping station treatment plant. 30 per cent of cost of labor and material, totaling approximately $79,000, is a grant.

Loan and grant for $109,000 to City of Girard, Ill., for water-works system, including elevated tank, pumping equipment, distribution system, to the City of Springfield, Ill., source of water supply. 30 per cent of cost of labor and material, approximately $81,000, is a grant.

Loan and grant of $188,000 to City of Virden, Ill., for construction of water-works system, including pumping equipment. 30 per cent of cost of labor and material, approximately $138,000, is a grant.

Loan and grant of $49,000 to Geneseo, Kan., for a water-works system, including wells and pumping equipment. Approximate cost of labor and material is $37,000, of which 30 per cent is a grant.

Loan and grant of $63,000 to Divernon, Ill., for construction of a water-works system, including storage tank, pumping equipment and main to City of Springfield, Ill., source of water supply. 30 per cent of cost of labor and material, approximately $46,000, is a grant.

Loan and grant of $84,000 to Peoria Heights, Peoria County, Ill., for improvements to water-works system, including two deep wells, pumping equipment and storage reservoir. Approximate cost of labor and material is $16,000, of which 30 per cent is a grant.

Loan and grant of $80,000 to Lake City, Wabasha County, Minn., for construction of a sewage treatment plant, sewage pumping station, and other municipal works. Approximate cost of labor and material is $61,000 of which 30 per cent is a grant.

Loan and grant for $299,000 to City of Auburn, Ill., for construction of water system, including pumping station, 150,000-gal. elevated tank, distribution system, to the City of Springfield (source of water supply). 30 per cent of cost of labor and material, approximately $232,000, is a grant.

Loan and grant for $63,000 to Village of Chatham, Sangamon County, Ill., for construction of water-works system, including 60,000-gal. elevated tank, distribution system, pumping equipment and water main to Springfield (source of water supply). 30 per cent of cost of labor and material, approximately $47,000, is a grant.

Loan and grant for $65,000 to City of Windsor, Shelby County, Ill., for well, pump house, pumping equipment, water tank and water distribution system. 30 per cent of cost of labor and material, approximately $49,000, is a grant.

Loan and grant of $60,000 to Madison, Jefferson County, Ind., for improvements to water-works system, including four deep wells and pumping equipment, and construction of power plant, including installation of two 200-kw. generators, diesel-driven. Approximate cost of labor and material is $49,000, of which 30 per cent is a grant.

Grant of $1,000 to Village of Paynesville, Minn., to aid in improvements to water-works system, including deep well, pump house and pumping equipment. No loan requested.

Loan and grant for $30,000 to Village of Stonington, Christian County, Ill., for remodeling and altering existing well house and pumping station for use as a water softener plant. Elevated water tank and extension of existing water system. 30 per cent of cost of labor and material, approximately $22,000, is a grant.

Grant of $8,100 to City of Atlantic, Cass County, Iowa, to aid in erection of 500,000-gal. steel elevated tank, two 80-ft. wells with pumps and accessories, and installation of spray pond equipment, connecting to condensers of pumping plants. Allotment represents 30 per cent of cost of labor and material of the project, of which total cost is $32,850.

Loan and grant of $112,000 to City of Roseville, Ill., for construction of a water well, and installation of pumping equipment. 30 per cent of cost of labor and material, approximately $9,000, is a grant.

Loan and grant of $72,000 for City of Montevideo, Minn., for construction of a sewer and sewage-treatment plant, including pumping station. 30 per cent of cost of labor and material, approximately $57,000, is a grant.

Loan and grant for $216,000 to City of Pekin, Ill., for construction of a sewage-treatment plant, pumping station and intercepting sewer. 30 per cent of cost of labor and material, approximately $162,000, is a grant.

Village of Footville, Rock County, Wis., to develop a present well, install pump station and water distribution system, a loan and grant for $30,000. 30 per cent of the cost and labor and material, which totals approximately $31,000, is a grant.

Loan and grant for $114,000 to Village of Barnesville, Ohio, for improvements to water-works system, including 68,000,000-gal. impounding reservoir, supply mains, pumping equipment, and 750,000-gal. elevated storage tank. Approximate cost of labor and material is $84,000, of which 30 per cent is a grant.

Loan and grant of $56,000 to Hope, Bartholomew County, Ind., for construction of water-works system, including two wells, pump house and equipment. Approximate cost of labor and material is $44,000, of which 30 per cent is a grant.

Loan and grant of $70,000 to City of Corbin, Whitley County, Ky., for extensions to existing water-distribution system, including chlorinator and metering equipment. 30 per cent of cost of labor and material, approximately $55,000, is a grant.

Loan and grant of $100,000 to the city of Danville, Ky., for improvements to water system, comprising pumping station, intake works, and supply main. Approximate cost of labor and material is $80,000, of which 30 per cent is a grant.

SOUTH

Loan and grant of $92,000 to Selmer, Tenn., for water-works system, including deep well and pumping equipment. 30 per cent of cost of labor and material, approximately $70,000, is a grant.

Loan and grant of $8,000 is a reallotment to Uniontown, Alabama, for use in improving water-works system, comprising pumping equipment, storage reservoir, and extension to distribution system. Cost of labor and material is $7,000, of which 30 per cent is a grant.

Loan and grant of $230,000 to City of Rome, Ga., for improvements to water-works system, including filtration plant and pumping equipment. Approximate cost of labor and material is $177,000, of which 30 per cent is a grant.

Loan and grant of $69,000 to Lake City, Columbia County, Fla., for improvements to water-works system, including two deep-well reservoirs, replacement of pumping equipment, and extensions to distribution system. 30 per cent of cost of labor and material, approximately $55,000, is a grant.

Loan and grant for $55,000 to Granite Falls, Caldwell County, N. C., for installation of two wells, construction of a pumping plant and elevated storage tank, and water distribution system. 30 per cent of cost of labor and material, approximately $43,000, is a grant.

Loan and grant for $200,000 to City of Greenwood, S. C., for construction of a dam on Coronata Creek to establish new water supply, construction of pumping station, filtration plant and water main. 30 per cent of cost of labor and material, approximately $155,000, is a grant.

Loan and grant for $32,000 to Walhalla, Oconee County, S. C., for construction of a dam across Shauga River, pumping station, including equipment, and cast-iron main. 30 per cent of cost of labor and material, $24,000, is a grant.

Loan and grant of $33,000 to Cameron, Calhoun County, S. C., for construction of a water-works system, including two deep wells, pump house and pumping equipment, and distribution system. Approximate cost of labor and material $23,000, of which 30 per cent is a grant.

Loan and grant of $66,000 to the city of Sumter, Sumter Co., S. C., for improvements to water-works system, including mains, installation of pumping equipment and extensions to distribution system. Approximate cost of labor and material is $61,000, of which 30 per cent is a grant.

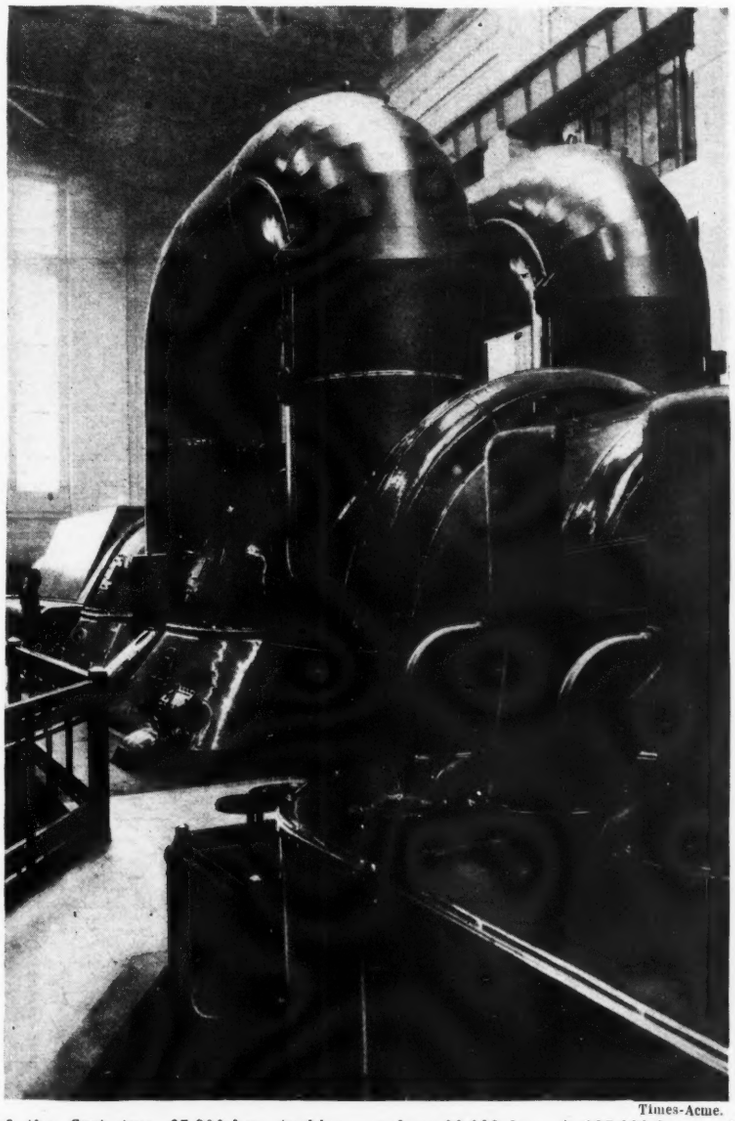
WEST

Loan and grant for $51,000 to City of McKinney, Collins County, Tex., for drilling an additional well, including installation of pumping equipment and extensions and replacements to water distribution system. 30 per cent of cost of labor and material, approximately $41,000, is a grant.

Loan and grant of $63,000 to City of Glen Rose, Somervell County, Tex., for construction of a water-works system with well, elevated tank, pump and distribution system. 30 per cent of the cost of labor and material, approximately $50,000, is a grant.

Loan and grant for $6,000 to City of Grandbury, County Tex., for improvements to water-works system, including deep-well pumping system, pump house. 30 per cent of cost of labor and material, which totals approximately $4,100, is a grant.

GIANT TURBINE-GENERATOR AT BATTERSEA



Times-Acme.

One of the first two 67,200-kw. turbine-generators at the new Battersea Power Station, London, of London Power Co. It develops 90,000 hp. A 105,000-kva. unit will be installed, by far the largest in England.

NEW BULLETINS

Hydraulic Packing—Chicago Belting Co., 113 N. Green St., Chicago, Ill. Leaflet describes this company's engineering service on hydraulic packing problems.

Fire-Clay Mortar—Harbison-Walker Refractories Co., Pittsburgh, Pa. 4-page folder offering free test sample of Harwaco Bond fire-clay refractory. Also 4-page leaflet, "278 Formulas Tested in Three Years Research before the Laboratory Said 'O.K.'"

Motor Application Chart—Engineering Department, The Louis Allis Co., 427 E. Stewart St., Milwaukee, Wis. Shows 29 different types of electric motors and lists proper motor for over 50 different standard applications. In chart form.

Automatic Weight Recorders—Streeter-Amet Co., 4101 Ravenswood Ave., Chicago, Ill. 12-page Catalog I.32, "Weigh It Automatically," describes unit for attachment to scales already installed, and capable of weighing up to 1,200 weights per hour.

Cast-Steel Valves—The Edward Valve & Mfg. Co., Inc., East Chicago, Ind. 56-page Section C of Catalog No. 11 covers globe and angle stop-check and feed-line stop-check types of cast-steel valves. All standard series from 300 to 1,500 lb. wsp., including specifications, dimensions and list prices. Catalog also includes secondary ratings and material specifications, special facings, remote operating devices, and information about by-passes, impactors and welding ends.

Refractory Cement — Johns-Manville, 22 East 40th St., New York, N. Y. 6-page bulletin, "Refractory Cements—Their Useful Characteristics and Some Recommendations as to Their Proper Use," includes specific condensed data.

Circuit Breakers—General Electric Co., Schenectady, N. Y. 4-page folder, "10,000 Operations Without Maintenance," which is G.E.A. 1822, describes Type FK-44B-Y1 oil-blast circuit breaker rated 600 amp., 15,000 volts, 100,000 kva.

Aeration and Filtration—Norton Co., Worcester, Mass. Air diffusers, plates and tube, for use in sewage disposal plants of the activated sludge type. 4-page folder.

Replacement Valve Handle — Pilgrim Brass Works, 146 Tyler St., Boston, Mass. 4-page folder describing valve handle of Bakelite to fit all types of valve stems.

Flexible Coupling — Link-Belt Co., 519 North Holmes Ave., Indianapolis, Ind. Three different types are tabulated and priced, with special emphasis on Type "RC," employing "Silverlink" roller chain for connecting two toothed coupling halves. Both revolving and stationary types of automatic-lubricating casings are included.

Rust Preventive—Dearborn Chemical Co., 310 South Michigan Ave., Chicago, Ill. "Proof of Results with No-Ox-id in the Railroad Field," includes application data of interest to power engineers.

Alloy Castings—International Nickel Co., Inc., 67 Wall St., New York, N. Y. 30-page booklet on Monel metal, nickel and high-nickel alloy castings. Of special interest is information on average composition and properties of cast nickel and high-nickel alloys on pages 28, 29 and 30.

Centrifugal Pumps—The LaBour Co., Inc., Elkhart, Ind. Bulletin No. 40, 16 pages, illustrates and describes this company's unit.

Graphite Lubricant—Acheson-Oildag Co., Port Huron, Mich. Technical Bulletin C113, "The Importance of Colloidal Graphited Lubricants in Running-In Operations," now available.

Bronze Castings—The Superheater Co., 60 East 42nd St., New York, N. Y. 16-page Bulletin B-1 describes rough or finished bronze castings in three distinct classes of mixture: standard bronzes, aluminum bronzes, and super-tensile manganese bronzes, and facilities in use for their production.

Automatic Combustion Control—Hagan Corp., 305 Ross St., Pittsburgh, Pa. Series DR bulletins describe construction and operation of improved units of automatic combustion control equipment. Includes eight separate bulletins.

Flow Meters Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. 24-page Catalog No. 700 includes complete data on new line of Republic flow meters with cartridge-sealed elements, including multiple-strip chart recorder, which keeps six records on evenly divided chart.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Russellville—City plans municipal light and power distribution system. Will make application to P.W.A. for $65,000 loan. Plan to purchase electricity from Tennessee Valley Authority at Muscle Shoals.

Calif., Crescent City — City seeking P.W.A. funds to finance construction municipal water system, light and power plant. $300,000. L. C. Lake, mayor.

Calif., Escondido—City made application to P.W.A. for $140,000 loan and $60,000 grant to finance construction of diesel power plant and electrical distribution system. J. H. Chase, 826 Civic Center Bldg., Los Angeles, engr.

Calif., Los Angeles—Jan. 29, by A. J. Holm, city purch. agt., City Hall, furnishing, delivering oil immersed, forced air cooled outdoor auto transformers, all incl. spare parts and necessary oil, Spec. 3265.

Calif., Los Angeles—Feb. 5, by A. J. Holm, city purch. agt., City Hall, synchronous condensers, Spec. 3267, as follows (1) 3-hydrogen cooled, outdoor type, complete (tools and spare parts) (2) 4, ditto; (1-alt.) ditto alternate to Item (1) (2-alt.) 4, ditto alternate to Item (2) (a) 3, f.o.b. cars Los Angeles (b) f.o.b. cars bidders shipping point, full freight allowed to Los Angeles (c) f.o.b. cars bidders shipping points.

Colo., Delta—City Council applied for P.W.A. loan of $150,000 for municipal electric power plant. Wood & Weber, 810 15th St., Denver, consult. engrs.

Colo., Fort Collins—City plans light plant and distributing system. $750,000. Loan and grant approved by P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Conn., Stratford—Town, D. S. Sammis, mgr., Town Hall, plans by A. W. Hagen, c/o town mgr., brick, steel, concrete municipal lighting plant. $100,000. **Maturity indefinite.**

Ill., O'Fallon—City voted $145,000 bonds for municipal light and power plant, incl. generating equipmen,t distribution lines. Applied for $145,000 grant and loan under P.W.A. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engr.

Ind., Fortville—City plans power plant. $65,000. P.W.A. project. Allen & Vagtborg, 205 West Wacker Dr., Chicago, engrs.

Ia., Gowrie—Town preliminary report completed constructing 2-150 kw. unit diesel generating plant and electrical distribution system. $80,000. Young & Stanley, Muscatine, engrs.

Ia., Lamont—City, M. A. Hydnden, clk., preliminary surveys municipal light and power plant and equipment. $100,000 (tentative). Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ia., Missouri Valley—City preliminary plans electric generating equipment, street lighting system, pumps, reservoirs and accessories. $47,288. J. J. Owen, Missouri Valley, engr.

Ia., Baton Rouge—Louisiana State University filed application for $101,375 P.W.A. loan for constructing power plant, incl. generating equipment, also for $45,478 loan for extensions to heating plant. Weiss, Dryefous & Seiferth, Architects Maison Blanche Bldg., New Orleans, engrs.

Kan., Independence—City, plans changing present water system to electric power, incl. 280-300 hp. oil engine and generator, 3 high duty centrifugal pumps. Filed application with state for loan and grant. G. Hackmaster, city engr.

Mass., Chelsea—City, L. F. Quigley, mayor, City Hall, plans municipal light plant. Engineer not appointed.

Mich., Gladstone—Municipality plans by F. R. Buechner, Gladstone, municipal electric power plant. $75,000.

Mo., Anderson—City, J. T. Kincannon, mayor, plans hydro-electric dam and power plant on local stream. $56,000. W. Christensen, city engr.

Mo., LaPlata—City, N. E. Young, mayor, plans light and power plant, equipment and distribution system, etc. Applied for $25,094 grant and $74,906 loan under P.W.A. E. T. Archer, 709 New England Bldg., Kansas City, engrs.

Mo., Monett—City plans light plant. $150,000. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, engrs. Will apply for loan and grant under P.W.A.

Mo., Pattenburg—City plans municipal light and power plant, equipment. $67,420. Applied for $17,420 grant and $50,000 loan under P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, engrs.

Mo., Perry—City plans light and power plant and equipment. $63,590. Applied for $13,590 grant and $50,000 loan under P.W.A. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engr.

Mo., St. Joseph—Joplin Steam Heating Corp., St. Joseph, plans steam heating, generating plant and distriution system. Applied for $150,000 loan under P.W.A.

Mo., Thayer—City plans municipal light and power plant building, equipment and distribution system. $110,000 loan and grant applied for under P.W.A. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, engrs.

Mo., Van Buren—Van Buren Light, Power & Ice Co., plans light and power generating plant, ice plant and electrical transmission system. Applied for $40,000 loan under P.W.A.

Mo., Weston — City plans light and power plant. $67,420. Applied $17,420 grant and $50,000 loan under P.W.A. E. T. Archer & Co., 609 New England Bldg., Kansas City, engrs.

N. J., Matawan—City Council plans new electrification of water plant and installing engine at cost $10,000.

N. M., Albuquerque — U. S. Indian Bureau, sketches electric power plant and copper water line at Shiprock Indian Agency. $80,000.

N. M., Roswell—New Mexico Military Institute, Roswell, plans central heating, light power, laundry and cleaning plant. $200,000. P.W.A. loan applied for. D. C. Pearson, supt.

N. Y., Yonkers—City plans rehabilitation of low service pumping station, by replacing present pumps with 3 motor driven centrifugal pumps. $74,104, incl. engineering, applied for $18,840 grant and $55,264 loan under P.W.A. C. J. Sheridan, city engr.

N. C., Asheville—City, G. L. Hackney, mgr., filed application with P.W.A. for loan for heating plant unit for city buildings. $570,000.

N. D., Crosby—Voted $85,000 electric light and power plant, total $85,000. Will ask loan under P.W.A. O. Woolfrey, city aud.

N. D., Devils Lake—City plans power plant. $300,000. Applied for P.W.A. loan and grant. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engrs.

N. D., Lidgerwood—City, F. W. Mashek, aud., plans municipal light and power plant. Will apply for $89,000 grant under P.W.A. May hold election to vote on $75,000 bonds for project. S. O. Quamme, city engr.

O., Bradford—City making plans power plant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

O., Lorain—City, J. Connelly, mayor, will apply for loan under P.W.A. for municipal light plant. $2,000,000.

Okla., Erick — City plans municipal light plant. $85,000. Applied for P.W.A. loan. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Eufaula—City plans light plant. $122,000. Applied for loan under P.W.A. H. C. Miller, Eufaula, engr.

Okla., Morris—City plans municipal light plant. $82,600. Applied for loan under P.W.A. T. J. Enbee, Okmulgee, engr.

Okla., Okeene—City plans installing 300 hp. Diesel engine generator set. $40,000. Applied for loan under P.W.A.

Okla., Pauls Valley—City plans light plant, $200,000. Applied for P.W.A. loan. V. V. Long & Co., Colcord Bldg., Oklahoma City, engr.

Okla., Shawnee — City plans electric light plant. $175,000. Applied for loan under P.W.A. P. S. Donnell, Oklahoma City, engr.

Okla., Stigler—City plans municipal light plant. $65,000. Applied for loan under P.W.A. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Temple—Town plans municipal light plant. $60,000. Applied for loan under P.W.A. P. S. Donnell, Oklahoma City, engr.

Okla., Wynnewood—City plans municipal light plant. $65,000. Applied for loan under P.W.A. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Pa., Bradford—City plans electric light and power plant. $1,175,000. P.W.A. project, submitted to Harrisburg.

R. I., Providence—Owner, c/o H. Marshak, archt., 36 Exchange Pl., plans provision terminal, including refrigeration and power plant, Kinsley Ave. To exceed $1,000,000.

S. C., Columbia—Columbia Railway & Navigation Co., Columbia, filed application with P.W.A. for loan to finance construction power plant and 2 large dams on Santee-Cooper Rivers. $34,000,000.

Tex., Hamilton—City, C. B. James, mayor, filed application with P.W.A. Bd. for constructing, equipping municipal light plant. $105,239. W. E. Collins, Hamilton, engr.

Va., Covington—Municipality plans electric power plant. $400,000. Will apply for loan under P.W.A. Wiley & Wilson, Richmond, engrs.

Vt., Burlington—Burlington Electric Light Dpt., J. E. Burke, mayor, preliminary estimates altering and constructing addition to electric light plant, incl. 2 new diesel engines and generator. To exceed $200,000. R. E. Palmer, 7 Montgomery Ave., Holyoke, Mass., engrs.

Man., Winnipeg—Winnipeg Hydro-Electric Co., I. G. Glarssco, mgr., bids in spring, for 2 new units at Slave Falls. $1,500,000.